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AMERICAN SOCIETY
FOR
TESTING MATERIALS

ORGANIZED IN 1898
INCORPORATED IN 1902

PROCEEDINGS
OF THE
THIRTY-SECOND ANNUAL MEETING

Held at Atlantic City, New Jersey
June 24-28, 1929

VOLUME 29

PART I. COMMITTEE REPORTS
NEW AND REVISED TENTATIVE STANDARDS

PUBLISHED BY
AMERICAN SOCIETY FOR TESTING MATERIALS
1315 Spruce Street, Philadelphia Pa.

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Printed in Philadelphia, U. S. A.
December, 1929

JAN 28 1930 ©Cl A 19263

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American Society for Testing Materials

ORGANIZED IN 1898
INCORPORATED IN 1902

PROCEEDINGS, PART I

The Society is not responsible, as a body, for the statements and opinions advanced in this publication.

SUMMARY OF THE PROCEEDINGS OF THE THIRTY-SECOND ANNUAL MEETING

ATLANTIC CITY, N. J., JUNE 24–28, 1929

THE THIRTY-SECOND ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS was held at Chalfonte-Haddon Hall, Atlantic City, N. J., June 24–28, 1929. The following is an analysis of the attendance at the meeting: Members in attendance or represented, 819; guests 115; total 934; ladies 269. The corresponding statistics for the Thirty-first Annual Meeting are: Members in attendance or represented, 809; guests, 93; total, 902; ladies, 286.

FIRST SESSION—TUESDAY, JUNE 25, 2 P. M.

Opening General Session

President G. W. Thompson in the chair.

The President in opening the annual meeting called attention to the recent activities and accomplishments of the committees and gave his impressions of the Society's work and of some of the problems before it. He stated that the indefatigable efforts that the members had shown in the past were a testimony to the work to be accomplished in the future. He then directed attention to the very complete program of the annual meeting which was replete with interesting technical papers and reports of committees.

Doctor Thompson announced that due to illness, Mr. A. A. Stevenson, an honorary member of the Society, was not able to attend this annual meeting. In recognition of the interest that Mr. Stevenson has shown in the Society and particularly in the annual meetings the Secretary was instructed to prepare a telegram to Mr. Stevenson extending the best wishes of the members for his complete recovery and the hope of seeing him at the next annual meeting.

The minutes of the Thirty-first Annual Meeting were approved as printed.

The report of Committee E-6 on Papers and Publications, C. L. Warwick, chairman, was presented by the Assistant Secretary, R. E. Hess. On motion, the report of the committee was adopted.

The report of Committee E-5 on Standing Committees discussing the considerations that led to the creation of a new Committee E-10 on Standards and presenting a number of modifications in the Regulations Governing Standing Committees to permit the committees to submit reports between annual meetings together with new tentative standards, was presented by the chairman, C. L. Warwick. On motion, the report of the committee was adopted.

The report of the Committee of Tellers, consisting of J. M. Darke and J. W. McBurney, appointed to canvass the letter ballot on election of officers, was received. The tellers reported that 1108 legal ballots had been cast, the votes being as follows:

For President, to serve for one year: T. D. Lynch, 1108 votes.

For Vice-President, to serve for two years: F. O. Clements, 1108 votes.

For Members of Executive Committee, to serve for two years:
G. B. Haven, 1108 votes.
C. R. Hook, 1108 votes.
H. E. Smith, 1108 votes.
G. E. Warren, 1106 votes.

In accordance with the ballot, the Chair declared the officers, listed above, elected.

The chairman then requested Past-Presidents W. H. Fulweiler and H. F. Moore to escort the President-elect to the chair. The President-elect, T. D. Lynch, expressed his appreciation of the honor of his election to the Presidency and the hope that the Society under his administration might continue the work which had been so brilliantly carried on by his predecessors. He also expressed the wish that the members would in the future as in the past continue to lend their best efforts both personally and in committee work to insure the continued success of the Society.

The Vice-President-elect, F. O. Clements, was escorted to the chair by Vice-President K. G. Mackenzie and Mr. T. R. Lawson. Mr. Clements thanked the members for the honor bestowed upon him, stating that he realized the office was one of responsibility and that he would do all that he could to live up to these responsibilities.

The meeting then adjourned and the second and third sessions were immediately convened.

SECOND SESSION—TUESDAY, JUNE 25, 3 P. M.

On Nomenclature, Research, and Methods of Testing

(Held Simultaneously with the Third Session)

President G. W. Thompson in the chair.

The report of Committee E-8 on Nomenclature and Definitions was presented by the chairman, Cloyd M. Chapman. The definitions appearing in the Tentative Specifications for Tolerances and Test Methods for Asbestos Yarns (D 299 – 28 T), as recommended by Committee D-13 on Textile Materials, were approved for advancement to standard. On motion, the report of the committee was adopted.

The report of Committee E-9 on Correlation of Research was presented by the chairman, H. F. Moore. This report discussed briefly the work of the committee during the year and reviewed the various research projects carried on by the Society's committees and through joint activities. As noted in the printed report, G. H. Clamer retires this year on the revolving membership plan and H. C. Mougey had been appointed by the Executive Committee for a term of five years to fill this vacancy. On motion, the report of the committee was adopted.

The report of Committee E-1 on Methods of Testing was presented by the chairman, W. H. Fulweiler. The work of the Section on Bend Testing was briefly outlined by H. F. Moore and was discussed. On motion, the report of the committee was adopted.

A paper entitled "Some Fundamental Definitions of Rheology" by Eugene C. Bingham, in the absence of the author was presented by title.

A paper entitled "The Determination and Significance of the Proportional Limit in the Testing of Metals" by R. L. Templin was presented by the author and discussed.

A paper entitled "Tension, Bend and Impact Tests on Reinforcing Bars," under the joint authorship of W. A. Slater and G. A. Smith, was presented by Mr. Slater.

A paper entitled "Fundamental Factors in the Testing of Mineral Products with Special Reference to Slate and Related Materials" by Oliver Bowles was presented by the author.

The meeting then adjourned till 8 p. m.

THIRD SESSION—TUESDAY, JUNE 25, 3 P. M.

On Rubber, Textiles, Coal and Timber

(Held Simultaneously with the Second Session)

Mr. S. T. Wagner in the chair.

The report of Committee D-13 on Textile Materials was presented by the chairman, W. H. Whitcomb. The proposed Tentative

Specifications for Asbestos Tape for Electrical Purposes and Specifications for Chafer Tire Fabrics were accepted for publication as tentative. The proposed revision of the Tentative Methods for Identification of Textile Fibers and Their Quantitative Determination in Mixed Goods (D 276 - 27 T) recommended by the committee was accepted, the methods being continued as tentative. The Tentative Specifications for Tolerances and Test Methods for Certain Light and Medium Cotton Fabrics (D 274 - 27 T); Specifications and Tolerances for 23/5/3 Carded American Tire Cord (D 298 - 28 T) and Specifications for Tolerances and Test Methods for Asbestos Yarns (D 299 - 28 T) were approved for reference to letter ballot of the Society for adoption as standard. The chairman announced that as a result of the resignation of D. C. Scott as second vice-chairman, and a change of employment of the chairman, an election of committee officers was held which resulted in the re-election of W. H. Whitcomb as chairman, and the election of W. E. Emley as second vice-chairman. On motion, the report of the committee was adopted.

The report of Committee D-11 on Rubber Products was presented by the chairman, L. C. Conradi. The committee recommended for adoption as tentative a new proposed Method of Test for the Hardness of Soft Rubber (in Slab Form) which it was not found possible to include in the report as preprinted. This method as proposed was accepted for publication as a tentative standard. The proposed revisions of the Tentative Methods of Chemical Analysis of Rubber Products (D 297 - 28 T) recommended by the committee were accepted, the methods being continued as tentative. On motion, the report of the committee was adopted.

A paper entitled "The Use of a Group of Performance Tests for Evaluating Rubber Compounds That Must Withstand Repeated Compression," under the joint authorship of Harlan A. Depew and E. G. Snyder, was presented by Mr. Depew.

The report of Committee D-5 on Coal and Coke, in the absence of the chairman, A. C. Fieldner, was presented by the vice-chairman, H. C. Porter. The proposed Tentative Methods of Test for Size of Anthracite and Test for Sieve Analysis of Crushed Bituminous Coal were accepted for publication as tentative. The proposed tentative revision of the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 - 27) was accepted for publication as tentative. The Tentative Methods of Test for Cubic Foot Weight of Crushed Bituminous Coal (D 291 - 28 T); Test for Cubic Foot Weight of Coke (D 292 - 28 T); Test for Sieve Analysis of Coke (D 293 - 28 T); and Tumbler Test for Coke (D 294 - 28 T) were approved for reference to letter ballot of the Society for adoption as standard. The proposed advancement to standard of the tentative revisions of the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 - 27) consisting of the Tentative Methods for the Determination of Sulfur in Coal and Coke by the Bomb-Washing and Sodium Peroxide Fusion Methods (D 271 - 27 T) and a revision in the procedure for the determination of phosphorus in ash was approved for reference to letter ballot of the Society for adoption. On motion, the report of the committee was adopted.

The report of the Sectional Committee on the Classification of Coal, in the absence of the chairman, A. C. Fieldner, was presented by H. C. Porter. On motion, the report of the committee was accepted for publication.

The report of Committee D-7 on Timber, in the absence of the chairman, Hermann von Schrenk, was presented by the secretary, J. A. Newlin. The proposed Tentative Definitions of Terms Relating to Timber were accepted for publication as tentative to supersede, when adopted, the present Standard Definitions of Terms Relating to Structural Timber (D 9 - 15). Mr. S. R. Church, chairman of Sub-Committee VI on Timber Preservatives, was called upon to present the proposed tentative revisions of the Standard Methods of Sampling and Analysis of Creosote Oil (D 38 - 27) and of the Method of Test for Distillation of Creosote Oil (D 246 - 28) which were accepted for publication as tentative. The proposed revision of the Standard Specifications for Structural Wood Joist, Planks, Beams, Stringers and Posts (D 245 - 27) as summarized in the report was accepted for publication as tentative. On motion, the report of the committee was adopted.

The report of Committee C-5 on Fire Tests of Materials and Construction was presented by the chairman, R. P. Miller. On motion, the report of the committee was adopted.

A paper entitled "A New Test for Measuring the Fire Resistance of Wood," under the joint authorship of T. R. Truax and C. A. Harrison, was presented from manuscript by Mr. Truax and discussed.

The meeting then adjourned till 8 p. m.

FOURTH SESSION—TUESDAY, JUNE 25, 8 P. M.

On Cast Iron and Symposium on Cast Iron

Mr. F. O. Clements in the chair.

The report of the Sectional Committee on Specifications for Cast-Iron Pipe, in the absence of the chairman, T. H. Wiggin, was presented by the Secretary-Treasurer. On motion, the report of the committee was accepted for publication.

The report of Committee A-3 on Cast Iron was presented by the chairman, Hyman Bornstein. The proposed Specifications for Gray-Iron Castings for Valves, Flanges and Pipe Fittings were accepted for publication as tentative. The proposed Tentative Specifications for Chilled-Tread Cast-Iron Wheels, to supersede when adopted the present Standard Specifications for Chilled Cast-Iron Wheels (A 46 - 24), were accepted for publication as tentative. The Tentative Specifications for the Arbitration Test Bar and Tension Test Specimen for Cast Iron (A 124 - 28 T) were approved for reference to letter ballot of the Society for adoption as standard. The tentative revisions of the Standard Specifications for Gray-Iron Castings (A 48 - 18); Specifications for Cast-Iron Soil Pipe and Fittings (A 74 - 18) and Specifications for High-Test Gray-Iron Castings (A 88 - 24) were approved for reference to letter ballot of the Society for adoption as standard. On motion, the report of the committee was adopted.

The Symposium on the Physical Properties of Cast Iron was introduced by Hyman Bornstein who stated that the symposium was being held as a result of a number of discussions that had taken place in Committee A-3. Cast iron is a reliable engineering material and a knowledge of its properties is necessary to encourage its proper use in industry. A committee under the chairmanship of Mr. Bornstein appointed to act in an advisory capacity to the Committee on Papers and Publications had arranged for the presentation of the papers, in the form of a symposium, which would give information on the classification of cast iron and on the important physical properties.

The classification, effect of section, static and elastic properties of cast iron were covered in five papers as follows:

"Classification of Gray-Iron Alloys" by J. W. Bolton—presented by the author.

"Effect of Section and Various Compositions on Physical Properties of Cast Iron" by R. S. MacPherran—presented by Max Kuniansky.

"Correlation of Test Bars and Castings" by W. H. Rother and V. M. Mazurie—presented by Mr. Mazurie.

"Static Strength of Plain and Alloy Cast Iron" by F. B. Coyle—presented by the author.

"Elastic Properties of Cast Iron" by J. T. MacKenzie—presented by the author.

The presentation of these papers was followed by discussion.

The subject of testing cast iron was covered in four papers as follows:

"The Fatigue Properties of Cast Iron" by J. B. Kommers—presented by the author.

"Impact Testing of Cast Iron" by Hyman Bornstein—presented by the author.

"Wear Testing of Cast Iron" by A. L. Boegehold—presented by the author.

"The Machineability of Cast Iron" by E. J. Lowry was presented by J. T. MacKenzie.

These papers were then discussed.

The corrosion and heat treatment of cast iron was covered in two papers as follows:

"Corrosion of Cast Iron" by H. O. Forrest—presented by the author.

"Heat Treatment of Cast Iron" by F. B. Coyle—presented by the author.

The symposium was then opened for general discussion.

The meeting then adjourned till the following morning.

FIFTH SESSION—WEDNESDAY, JUNE 26, 9.30 A. M.

On Steel and Wrought Iron

(Held simultaneously with the Sixth Session)

Past-President J. H. Gibboney in the chair.

The report of Committee A-2 on Wrought Iron, in the absence of the chairman, H. W. Faus, was presented by the vice-chairman, James Aston. The proposed tentative revisions of the Standard Specifications for Welded Wrought-Iron Pipe (A 72 - 27); for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 - 27); for Staybolt, Engine-Bolt and Extra-Refined Wrought-Iron Bars (A 84 - 27) and for Hollow Rolled Staybolt Iron (A 86 - 27) were accepted for publication as tentative. On motion, the report of the committee was adopted.

The report of the Sectional Committee on Standardization of Dimensions and Material of Wrought-Iron and Wrought-Steel Pipe and Tubing was presented by the chairman, H. H. Morgan. A table of dimensions and weights of lap-welded and seamless steel pipe for high-temperature service developed by this committee for the immediate relief of an industry had been incorporated by Committee A-1 on Steel in the Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 - 28T) being recommended for advancement to standard this year. The recommendation that this table be submitted to the American Standards Association for approval as American Tentative Standard had been referred to the Executive Committee for consideration. On motion, the report of the sectional committee was accepted for publication.

The report of Committee A-6 on Magnetic Properties was presented by the chairman, Thomas Spooner. The proposed Tentative Definitions of Magnetic Terms, with Units and Symbols, Relating to Magnetic Testing were accepted for publication as tentative. The proposed tentative revision of the Standard Methods of Test for Magnetic Properties of Iron and Steel (A 34 – 28) was accepted for publication as tentative. On motion, the report of the committee was adopted.

The report of Committee A-8 on Magnetic Analysis was presented by the chairman, R. L. Sanford. On motion, the report of the committee was adopted.

The report of Committee A-1 on Steel was presented by the chairman, J. B. Young. The proposed Tentative Specifications for Heat-Treated Carbon-Steel Helical Springs were accepted for publication as tentative. The proposed Specifications for Carbon-Steel Forgings for Locomotives were accepted for publication as tentative, superseding the present Standard Specifications for Carbon-Steel Forgings for Locomotives (A 20 – 28) which were accordingly withdrawn as recommended by the committee.

The proposed revisions of the Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings (A 17 – 21); and for Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57 – 24), presented for the first time, were unanimously approved for reference to letter ballot of the Society for adoption as standard, this recommendation requiring a nine-tenths vote.

The proposed tentative revisions of the following standard specifications were accepted for publication as tentative:

For Open-Hearth Carbon-Steel Rails (A 1 – 27);
For Carbon-Steel and Alloy-Steel Forgings (A 18 – 28);
For Welded and Seamless Steel Pipe (A 53 – 27);
For Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 – 27).

The proposed revision of the Tentative Specifications for Marine Boiler Steel Plates (A 114 – 28 T) was accepted, the specifications as revised being continued as tentative.

The committee recommended that the Tentative Specifications for Carbon-Steel Castings for Valves, Flanges and Fittings for High-Temperature Service (A 95 – 28 T) be revised as indicated in the report and the specifications as revised advanced to standard. This recommendation was discussed and then submitted to a vote requiring for adoption a two-thirds vote of those voting. On motion, the recommendation was approved by a vote of 43 affirmative and 11 negative, the specifications, as revised, to be referred to letter ballot of the Society for adoption as standard. The proposed revision of the Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 – 28 T) was accepted and the specifications, as revised, approved for reference to letter ballot of the Society for adoption. The Tentative Specifications for Structural Steel for Locomotives and Cars (A 113 – 28 T) were approved for reference to letter ballot of the Society for adoption as standard to supersede the present Standard Specifications for Structural Steel for Locomotives (A 10–24) and for Structural Steel for Cars (A 11–24) which specifications were accordingly withdrawn as recommended by the committee.

The advancement to standard of the tentative revisions recommended in 1928 of the following standard specifications was accepted for reference to letter ballot of the Society for adoption:

For Structural Steel for Bridges (A 7 – 24);
For Structural Nickel Steel (A 8 – 24);
For Structural Steel for Buildings (A 9 – 24);
For Structural Silicon Steel (A 94 – 27).

On motion, the report of the committee was adopted.

A paper entitled "The Effect of Reduction from Ingot to Forging in Steel Forgings" was presented from manuscript by the author, L. H. Fry, and discussed.

The report of the Research Committee on Yield Point of Structural Steel was presented by the chairman, M. O. Withey, and discussed. On motion, the report of the committee was accepted for publication.

A verbal report of progress of the Joint Committee on Investigation of the Effect of Phosphorus and Sulfur in Steel was presented by the chairman, G. K. Burgess.

The report of the Research Committee on Effect of Tin and Arsenic on High-Speed Tool Steel was presented from manuscript by the chairman, N. B. Hoffman. On motion, the report of the committee was accepted for publication.

An outline of its organization and a brief report on the activities of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and

Related Alloys was presented by the chairman, Jerome Strauss.

The session then adjourned till 4 p. m.

SIXTH SESSION—WEDNESDAY, JUNE 26, 9.30 A. M.

On Lime, Gypsum, Brick, Refractories, Tile, Slate and Building Stone

(Held Simultaneously with the Fifth Session)

Mr. T. R. Lawson in the chair.

The report of Committee C-11 on Gypsum, in the absence of the chairman, J. W. Ginder, was presented by J. A. Murray. The proposed revision of the Tentative Specifications for Keene's Cement (C 61 – 28 T) was accepted, the specifications as revised being continued as tentative. The proposed revision of the Tentative Specifications for Calcined Gypsum for Use in the Preparation of Dental Plasters (C 72 – 28 T) was accepted with one change, namely, the deletion of the phrase "the testing consistency" from Section 9, the specifications as revised being continued as tentative. The proposed revisions of the Definitions for Consistency and Plasticity appearing in the Tentative Definitions of Terms Relating to the Gypsum Industry (C 11 – 28 T) were accepted, the definitions as revised being continued as tentative. The proposed rewording of the Definition for Gypsum Partition Tile or Block appearing in the Standard Specifications C 52 – 27 was accepted and will be published with the Tentative Definitions of Terms Relating to the Gypsum Industry (C 11 – 28 T). The report as preprinted had recommended that the Definitions for Gypsum Plaster Board and Gypsum Wall Board be advanced to standard. These definitions had not as yet been approved by Committee E-8 on Nomenclature and Definitions and the committee accordingly withdrew its recommendation for advancement to standard and recommended that the definitions be continued as tentative in their present form.

The committee recommended that the Tentative Specifications for Gypsum Molding Plaster (C 59 – 26 T) and for Gypsum Pottery Plaster (C 60 – 26 T) be advanced to standard with the inclusion in Section 9 on Packing and Marking of both specifications of a provision for 100-lb. paper sacks. The tentative specifications as thus revised were accepted and approved for reference to letter ballot of the Society for adoption as standard. On motion, the report of the committee, as revised, was adopted.

The report of Committee C-4 on Clay and Cement-Concrete Pipe was presented by the chairman, George T. Hammond. On motion, the report of the committee was adopted.

The report of Committee C-3 on Brick was presented by the vice-chairman, H. T. Shelley. The proposed revisions of the Tentative Specifications for Paving Brick (C 7 – 28 T) were accepted, the specifications as revised being continued as tentative. The committee recommended for advancement to standard the Tentative Specifications for Building Brick (Made from Clay or Shale) (C 62 – 28 T). This recommendation was discussed on the floor of the annual meeting and T. C. Taylor moved that the crushing strength requirements be eliminated from the tentative specifications. There was no second to this motion. On motion, the tentative specifications were then approved for reference to letter ballot of the Society for adoption as standard as recommended by the committee. The withdrawal of the Standard Specifications for Paving Brick (C 7 – 15) was approved. On motion, the report of the committee was adopted.

A paper entitled "The Water Absorption and Penetrability of Brick" by J. W. McBurney was presented by the author and discussed.

The report of Committee C-8 on Refractories, in the absence of the chairman, G. A. Bole, was presented by the secretary, L. J. Trostel. The proposed tentative revision of the Standard Method of Test for Softening Point of Fire-Clay Brick (C 24 – 20) was accepted for publication as tentative. On motion, the report of the committee was adopted.

The report of Committee D-16 on Slate was presented by the chairman, W. B. Plank. On motion, the report of the committee was adopted.

A paper entitled "Tests of Elastic Caulking Compounds" by H. H. Dutton was presented by the author and discussed.

The report of Committee D-18 on Natural Building Stones, in the absence of the chairman, F. Y. Joannes, was presented by the secretary, H. S. Brightly. On motion, the report of the committee was adopted.

The report of Committee C-7 on Lime, in the absence of the chairman, H. C. Berry, was presented by the Assistant-Secretary. The Tentative Methods of Chemical Analysis of Limestone, Quicklime and Hydrated Lime (C 25 – 27 T) were approved for reference to letter ballot of the Society for adoption as standard. On motion, the report of the committee was adopted.

The meeting then adjourned till 4 p. m.

SEVENTH SESSION—WEDNESDAY, JUNE 26, 4 P. M.

Edgar Marburg Lecture and Award of Charles B. Dudley Medal

President G. W. Thompson in the chair.

The President in opening the session described briefly the reasons for the institution of the Edgar Marburg Lecture and the double purpose that was attached to it, namely, to commemorate the name of the first Secretary of the Society, and to receive inspiration from some eminent engineer who in his lecture would bring to the members recent developments in the sciences in which the Society is interested.

He then introduced Dr. Saul Dushman, Assistant Director of the Research Laboratory of the General Electric Company, as the Fourth Edgar Marburg Lecturer. Doctor Dushman chose as the subject of his lecture "The Nature of Cohesive Forces in Solids." This choice was eminently fitting, the address bringing out the close relationship between the work of the physicist and the engineer. The views of present-day physics on the orbital arrangement of particles to form atoms were outlined by the lecturer, and the relation of the revolving particles of adjacent atoms and how this relation establishes the cohesion of the material were discussed. Ductility and malleability were observed to be intimately dependent upon the type of lattice structure. The lecturer stated that the fact that atoms are arranged in regular lattice formations leads to revised views on the nature of the so-called secondary valence of forces. Cohesional forces are essentially no different from chemical forces except in order of magnitude. The effect of temperature on the rupture strength was discussed at length by Doctor Dushman.

President Thompson in thanking Doctor Dushman for his excellent address presented to him on behalf of the Society the Edgar Marburg Lecture Certificate.

Following the lecture, Doctor Thompson recognized Mr. W. H. Bassett, chairman of the Committee on Award of the Charles B. Dudley Medal who presented Messrs. J. J. Kanter and L. W. Spring as the recipients of the medal for their paper on "'Long-Time' or 'Flow' Tests of Carbon Steels at Various Temperatures with Particular Reference to Stresses Below the Proportional Limit" presented at the 1928 annual meeting. After the President had made the award, Mr. Kanter expressed his appreciation of the honor of participating in the award of the Dudley Medal:

> Mr. President, ladies and gentlemen: It is with a great deal of pleasure that I participate in receiving the Dudley Medal. It has been a great privilege to have been associated with Mr. Spring in this work, whose contributions to this field of testing extend back over a good many years. The testing of metals at high temperatures is a very fascinating field of endeavor, and many of the leaders in this work are active in this Society. Through our contact with these men and their work, we have been greatly aided in our own efforts, and we feel of course that a large amount of the credit due in receiving this medal reflects upon those men. Moreover, we are greatly indebted to the fellow workers in

our organization, whose enthusiasm and support meant so much in realizing this work which the Society has deemed worthy of this great compliment. Thank you.

Mr. Spring in accepting the medal thanked the Society for the honor conferred and referred briefly to some of the developments during the past fifteen or twenty years that led to the modern methods of high-temperature testing:

It might interest you to have a short bird's-eye view of high-temperature testing, particularly during the past fifteen or twenty years. It seems that our laboratory happened to be in about the right place at the right time and that may be one reason why this honor comes to us to-day. We had the good fortune to be among the first in what we might call the modern group of high-temperature workers in this country.

Since about 1820 high-temperature testing has been going on. The first of it, of course, was very crudely done and comparatively little work of what now would be considered fair accuracy was done up to about 1890. In 1820 Tremery and Proirier-Saint-Brice reported that at red heat wrought iron had only about one-sixth of the strength of that at ordinary temperatures. In a report of a committee of The Franklin Institute of Philadelphia in 1837, working on the explosion of steam boilers, the loss in strength of boiler plate and copper tubes was discussed on tests made up to 1300° F. From those years down to the present, there have been recorded many investigations in Europe and this country, including those by Huston, Howard, Rudeloff, Carpenter, Bach, Martens, Charpy, Le Chatelier and Hadfield.

The beginning of our own work was brought about around 1908 or 1909 when we were asked by our president to give him the tensile strength of three of our most-used cast bronzes at a temperature of 750° F. Temperatures in steam power stations were then going higher and he knew that the strength of bronze was not the same at the higher temperatures as at temperatures at which materials usually were tested. This was a new problem for us. We went through the literature pretty well and found that the earlier people had done their testing in various ways—some of them yielding inaccurate results when judged by present day standards. Some had heated their test specimens in a forge or in muffle furnaces, removing them to the testing machine and making the test as rapidly as possible with the temperature of the test specimen continually falling. Bach, Rudeloff and several others constructed vessels filled with molten salts, metals or even gases, heated externally by gas or other flame. The test specimens extending through these vessels were tested when the thermometer immersed in the fluid in the vessel showed proper temperature. Stribeck in Germany was using an electric coil but we did not know it at that time. We felt that we perhaps had an advantage in the modern electric current so we improvised an electric heating unit from sheet iron, sheet asbestos insulation and nickel wire. This electric heating was original so far as we were concerned and crude enough to deserve being original. At first we were afraid of the possible effect of induction until careful tests proved conclusively that even several times the amount of current which we needed to maintain our highest temperature gave concordant results on steel, cast iron and the bronzes. Anyway, we completed and reported the tests on these three bronzes at one temperature, 750° F., and the man who had asked for them was satisfied and apparently thought that we were going to stop. However, we continued with quite a series of tests on cast and forging metals, testing other bronzes, Monel metal, steel, cast iron, as well as various rolled materials which we were using for valve stems and studs. These results were published in 1912 and republished several times since.

Since that time operating temperatures in steam power plants, and lately in the oil refineries, have advanced more or less continuously. Designing engineers, therefore, have required much data on the strength of the materials available and there shortly developed quite a coterie of workers, many of whom you know, who have done great service in high-temperature testing. I must mention particularly the high-temperature committee which was organized following the Symposium on High-Temperature Testing at Cleveland in 1924. This committee is acting as a sort of clearing house for high-temperature testing in this country.

Up to about five years ago the work was what is generally called "short-time" high-temperature testing, the test specimens being heated and held at the desired temperature only from one-half hour to possibly two or three hours, without load. After uniformity has been attained, the testing machine is set in motion and the test made, the duration of load, therefore, being usually not more than a few minutes and the time under temperature being only two or three hours at most. Of course this does not really represent present pressure and temperature conditions in our power plants and oil refineries where pressures of 600 to 1500 lb. per sq. in. and temperatures of 700 to 1000° F. or more are in regular use. Pressure is practically continuous on boilers, piping and valves as also are the temperatures. An electric lighting plant, for instance, has to furnish light and power to its customers day and night, week after week and month after month. Therefore there is needed in our laboratories tests of longer duration as to time and temperature than the short-time tests described. About five years ago in England, Dickinson made experiments along this line. He found that with long-continued temperature and stress a small stretch which he called "creep," but which also is called "flow," is produced at stresses lower than the short-time elastic limit which formerly had been considered the lowest stress at which any permanent stretch could be produced. This "flow" is continuous at high enough stress and temperature and its rate roughly is proportional to the amount of stress. These tests, being slow, require special testing machines since regular testing equipment usually cannot be spared for the necessary length of time, nor is it well adapted to the work. Some materials in flow testing are kept under continuous stress and temperature for months.

These latter or flow tests are of the kind dealt with in our paper before the Society last year. Information of this kind is very necessary to the engineer. He must design and build equipment for oil refineries working at 900, 1000, and 1200° F., and higher temperatures are being talked of and even tried in an experimental way. Steam power plants, as stated, now are working at steam pressures of 600 and 1500 lb. and at temperatures of 750° F. with 1000° F. temperatures in view—a low red heat. It will be seen, therefore, that this work is necessary in order to give the engineer and designer the information they seek.

I have tried to give you a little picture of what this subject is all about, and I wish to thank the Society for this honor, which is highly appreciated.

I know that Mr. Kanter feels this way also. Some of the credit which comes to us should go to the organization back home, however, which furnished us the inspiration, the equipment and the time to do this high-temperature testing. Thank you.

The meeting then adjourned till 8.15 p. m.

EIGHTH SESSION—WEDNESDAY, JUNE 26, 8.15 P. M.

Presidential Address and Report of Executive Committee

Past-President W. H. Fulweiler in the chair.

The Secretary-Treasurer presented the annual report of the Executive Committee which discussed membership activities, the organization of a new Committee E-10 on Standards involving a modification in the Society's standardization procedure, publications, finances and administrative matters relating to committee activities and relations with other societies. The revisions of the by-laws,[1] recommended by the Executive Committee, were approved for reference to letter ballot of the Society for adoption.

On motion, the report of the Executive Committee was adopted.

The chairman introduced President G. W. Thompson who delivered his Presidential Address on the subject "Standardization and Good Will." Doctor Thompson analyzed the functions of standard specifications and emphasized their value in the case of materials for engineering used in quantity for specific purposes. He raised the question whether a producer who establishes a reputation by furnishing constantly a material of extreme satisfaction to the consumer will lose by the development of a standard specification for that product. His answer was that a producer can gain much greater good will through the tested performance of his product under a recognized standard than is possible when there is no standard or test and when price alone governs. He stated that the Society occupies an impregnable position in the field of standardization of engineering materials, impregnable so long as we perform our functions rationally, justly and with a continuous process of development.

The meeting then adjourned till the following morning and was followed by an informal dance and smoker.

NINTH SESSION—THURSDAY, JUNE 27, 9.30 A. M.

On Corrosion and Fatigue of Metals

(Held simultaneously with the Tenth Session)

Vice-President T. D. Lynch in the chair.

The report of Committee A-5 on Corrosion of Iron and Steel was presented by the chairman, J. H. Gibboney. On motion, the report of the committee was adopted.

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[1] See p. 64.

A paper entitled "A Critical Study of the A.S.T.M. Corrosion Data on Uncoated Commercial Iron and Steel Sheets" under the joint authorship of V. V. Kendall and E. S. Taylerson was presented by Mr. Kendall and discussed.

A paper entitled "A Method of Treating Data on the Lives of Ferrous Materials" under the joint authorship of R. F. Passano and Anson Hayes was presented by Mr. Passano and discussed.

A paper entitled "Method of Making Copper Replicas of Corroded Metal Objects" by E. S. Taylerson was presented by the author and discussed.

The report of the Sectional Committee on Zinc Coating of Iron and Steel was presented by the chairman, J. A. Capp. The proposed revisions of the Tentative Specifications for Zinc Coatings on Structural Steel Shapes, Plates, Bars and Their Products (A 123 - 28 T) were accepted, these specifications being continued as tentative. On motion, the report of the sectional committee was accepted for publication.

The report of Committee D-14 on Screen Wire Cloth was presented by the chairman, R. W. Woodward. The Tentative Specifications for Non-Ferrous Insect Screen Cloth (B 50 - 27 T) were approved for reference to letter ballot of the Society for adoption as standard. On motion, the report of the committee was adopted.

The report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys, in the absence of the chairman, T. S. Fuller, was presented by the vice-chairman, H. S. Rawdon. In presenting the report Mr. Rawdon called on W. H. Finkeldey to present the report of Sub-Committee VI on Atmospheric Corrosion, and on A. E. Flowers to present the report of Sub-Committee VIII on Galvanic and Electrolytic Corrosion. On motion, the report of the committee was adopted.

The report of Society representatives on Joint Research Committee on Boiler Feed Water was presented by Max Hecht. The report as preprinted referred to proposed Methods for Determination of Dissolved Oxygen in Boiler Feed Water and on recommendation of the representatives these methods were accepted, subject to the approval of Committee E-6 on Papers and Publications, for publication as information with the report.[1] On motion, the report of the Society representatives was accepted for publication.

The report of the Research Committee on Fatigue of Metals was presented by the chairman, H. F. Moore. On motion, the report of the committee was accepted for publication.

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[1] The publication of these methods was subsequently approved by Committee E-6.

A paper entitled "Corrosion of Metals Under Cyclic Stress" by D. J. McAdam, Jr., was presented by the author and discussed.

A paper entitled "The Influence of Corrosion Accelerators and Inhibitors on Fatigue of Ferrous Metals" under the joint authorship of F. N. Speller, I. B. McCorkle and P. F. Mumma was presented by Mr. Speller and discussed.

A paper entitled "Fatigue Tests of Large Specimens" by R. E. Peterson was presented by the author and discussed.

The meeting then adjourned till 8 p. m.

TENTH SESSION—THURSDAY, JUNE 27, 9.30 A. M.

On Paint, Petroleum Products, Road Materials, Waterproofing, and Electrical Insulating Materials

(Held Simultaneously with the Ninth Session)

Vice-President K. G. Mackenzie in the chair.

The report of Committee D-1 on Preservative Coatings for Structural Materials was presented by the chairman, Allen Rogers. The proposed Tentative Specifications for Soluble Nitrocellulose; Ethyl Acetate; Butyl Acetate; and Butanol were accepted for publication as tentative. As preprinted the report had submitted proposed Specifications for Amyl Acetate for publication as tentative but the committee withdrew this recommendation.

The proposed Methods of Routine Determination of Acetone Extract in Dry Lampblack and Dry Bone Black, and Tests for Determination of Polishing Lubricant in Aluminum Powder for Paints were accepted for publication as tentative as recommended by the committee.

The committee recommended that the proposed Tentative Method of Analysis for the Color Characteristics of Paints in Terms of Fundamental Physical Units as preprinted in the report be revised as follows and the method as revised be accepted for publication as tentative:

Replace the introductory note reading as follows:

> This method determines the color characteristics of a paint in terms of fundamental physical units. It is intended for use in connection with specifications for paint which in addition to the specified color characteristics must also include the paint formula indicating at least approximately the standard or preferred composition and type of the paint required under the specification.

with the following note:

> This method determines the color characteristics of a paint in terms of fundamental physical units. The appearance of a painted surface may however be influenced by properties in addition to color, notably degree of gloss.

Section 2.—Change this section from the following form as preprinted:

> 2. The reflection factor of the standard reflecting surface shall be known. The flat even surface of a block of pure magnesium carbonate makes a very suitable standard.

to read as follows:

> 2. The spectral reflection curve of the standard reflecting surface shall be known. The flat, even surface of a block of pure magnesium carbonate, if freshly and heavily fumed with magnesium oxide, makes a very suitable nonselective standard that is easily reproducible. The reflection factor of the standard reflecting surface shall be tentatively assumed as 98 per cent.

Section 3.—Change this section from the following form as preprinted:

> 3. The character, color, intensity and location of the light source for the incident illumination on the surfaces of the standard and the sample shall be definitely specified.
>
> NOTE.—The character of the light source includes the angle of incidence and whether the illumination is a point source, diffuse or partially diffuse. In certain instances, colors subject to change can be analyzed under illumination of lower intensity than that normally employed. In such instances the special illumination employed shall be completely specified. The accuracy of results obtained under such conditions is naturally limited to a shorter range of wave lengths than that obtainable with higher intensity.

to read as follows:

> 3. The sample and standard shall be illuminated under identical conditions.
>
> NOTE.—Diffuse illumination offers the most generally reproducible method of illuminating both sample and standard. It is recommended that for an intercomparison of results this type of illumination be used.

With these revisions the proposed method was accepted for publication as tentative subject to a subsequent favorable letter ballot of Committee D-1.[1]

The committee recommended that with the addition of the following method for color the proposed Tentative Methods of Sampling and Testing Shellac be accepted for publication as tentative to supersede, when adopted, the present Standard Methods of Testing Shellac

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[1] The subsequent letter ballot on this recommendation resulted in 50 affirmative and 1 negative votes with 13 members not voting.

(D 29 – 25) and the Standard Methods for Determination of Wax in Shellac (D 29 – 28):

Color.—Add the following new Section 23 on Color and change the present section numbers accordingly:

> 23. Digest a weighed portion of the shellac with twice its weight of cold 95-per-cent alcohol, shaking at intervals until the shellac is entirely "cut" and proceed in accordance with Section 25 by the particular method agreed upon by the purchaser and seller.

With this revision the proposed methods were accepted for publication as tentative subject to a subsequent favorable letter ballot of Committee D-1.[1]

As preprinted the report had recommended that the Standard Specifications for Dry Bleached Shellac (D 207 – 26) and the Specifications for Orange Shellac (D 237 – 27) be revised and continued as standard. Since the Methods of Testing Shellac were being recommended for publication as a tentative standard, the committee now recommended that the proposed revised specifications be issued as tentative standards. In addition, the following revisions were recommended in the proposed Tentative Specifications for Orange Shellac:

Section 1.—Change this section from its preprinted form: namely,

> 1. These specifications cover four grades of orange shellacs, namely, Grade A, Grade B, Grade C, and Grade D. Stick, seed, garnet and button lacs are not included under the grades of shellac covered by these specifications.
>
> NOTE.—Grade A, in general, will include grades of shellac known in the trade as D. C., VSO, Diamond I, Double Triangle G, and Superfine.
>
> Grade B, in general, will include the grades known in the trade as Fine, Good and Heart Brands.
>
> Grade C represents the grade known in the trade as Pure TN.
>
> Grade D represents the grade known in the trade as U. S. S. A., TN, and may contain up to 3 per cent of rosin.

to read as follows:

> 1. Orange shellacs may, for convenience, be grouped into the following four grades: Grade A, Grade B, Grade C, and Grade D. Stick, seed, garnet and button lacs are not included under these grades.

Section 2.—Add the following additional requirement for color:

> Color..........When specified the color shall be no darker than that of a sample mutually agreed upon by purchaser and seller.[a]

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[a] Attention is called to the fact that purchaser and seller must agree upon one of the two methods for determining color appearing in Methods D 29 – 29 T.

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[1] The subsequent letter ballot on this recommendation resulted in 48 affirmative and no negative votes with 16 members not voting.

The specifications as revised were accepted for publication as tentative, subject to a subsequent favorable letter ballot of Committee D-1.[1]

The proposed revision of the Standard Methods of Routine Analysis of Dry Red Lead (D 49 - 28), presented for the first time, was unanimously approved for reference to letter ballot of the Society for adoption as standard, this recommendation requiring a nine-tenths vote.

The advancement to standard of the tentative revisions of the Standard Methods of Routine Analysis of Titanium Pigments (D 186 - 27) was approved for reference to letter ballot of the Society for adoption.

The proposed revisions of the Tentative Methods of Test for Bleeding of Pigments (D 279 - 28 T) and Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 - 27 T) were accepted, the methods as revised being continued as tentative.

The following tentative methods were approved for reference to letter ballot of the Society for adoption as standard:

Methods of Test for Coarse Particles in Dry Pigments and Coarse Particles and Skins in Mixtures of Pigments and Vehicles (D 185 - 28 T) to supersede the present Standard Method of Test for Coarse Particles in Paint Pigments (D 185 - 26);

Methods of Routine Analysis of White Linseed Oil Paints (D 215 - 28 T);

Method of Routine Analysis of Dry Cuprous Oxide (D 283 - 28 T);

Method of Routine Analysis of Dry Mercuric Oxide (D 284 - 28 T).

The report as preprinted had recommended that the Tentative Specifications for Titanium Barium Pigment (D 265 - 27 T) be revised and advanced to standard. The committee withdrew this recommendation and recommended that the Tentative Specifications D 265 - 27 T be withdrawn. This recommendation of the committee was approved subject to a subsequent favorable letter ballot of Committee D-1.[2]

The withdrawal of the Standard Method of Test for Coarse Particles in Paint Pigments (D 185 - 26) and the Tentative Methods of Test for Mass Color and Tinting Strength of Pigments (D 282 - 28 T) and Methods of Testing Shellac Varnish (D 214 - 27 T) was approved.

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[1] The subsequent letter ballot on this recommendation resulted as follows: Tentative Specifications for Dry Bleached Shellac, 48 affirmative, 1 negative votes and 15 members not voting; Tentative Specifications for Orange Shellac, 44 affirmative, 1 negative votes and 19 members not voting.

[2] The subsequent letter ballot on this recommendation resulted in 46 affirmative and no negative votes with 18 members not voting.

On motion the report of the committee, as revised, was adopted.

A paper entitled "The True Tinting Strength of White Pigments" by G. W. Thompson was presented by the author and discussed.

A paper entitled "The Effect of Storage on the Properties of Turpentine" under the joint authorship of W. B. Burnett and H. K. Salzberg was presented by Mr. Burnett and discussed.

The report of Committee D-8 on Bituminous Waterproofing and Roofing Materials, in the absence of the chairman, S. T. Wagner, was presented by the vice-chairman, C. N. Forrest. The proposed Tentative Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings and the proposed Tentative Method of Test for Coarse Particles in Bituminous Materials by Means of Elutriation were accepted for publication as tentative. The proposed revision of the Standard Specifications for Asphalt Roll-Roofing and Asphalt Shingles Surfaced with Mineral Granules (D 225 - 27), presented for the first time, was unanimously approved for reference to letter ballot of the Society for adoption as standard, this recommendation requiring a nine-tenths vote. The proposed revision of the Tentative Methods of Analysis of Roofing Felt for Fiber Composition (D 272 - 27 T) was accepted, the methods being continued as tentative. On motion, the report of the committee was adopted.

The report of Committee D-2 on Petroleum Products and Lubricants was presented by the chairman, F. A. Hull. The proposed Tentative Method of Test for the Determination of Expressible Oil and Moisture in Paraffin Waxes was accepted for publication as tentative.

The proposed tentative revisions of the following standards were accepted:

Method of Test for Viscosity of Petroleum Products and Lubricants (D 88 - 26);
Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (D 86 - 27);
Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 - 28);
Method of Test for Carbon Residue of Petroleum Products (Conradson Carbon Residue) (D 189 - 28).

The proposed revisions of the Tentative Method of Test for Sulfur in Naphthas and Illuminating Oils (D 90 - 26 T) and the Test for Precipitation Number of Lubricating Oils (D 91 - 21 T) were accepted, the methods being continued as tentative.

In addition to the recommendations concerning standards and tentative standards appearing in the report as preprinted, the committee recommended the following revision of the Tentative Method of Test for Distillation of Crude Petroleum (D 285 - 28 T):

Section 2.—In the last sentence change the angle that the vapor tube makes with the Hempel flask from 80 deg. to read 75 deg.

Figure 1.—Change the angle which the vapor tube makes with the Hempel flask from 80 deg. to 75 deg.

Section 5.—In the second sentence change 80 deg. to read 75 deg.

These revisions were accepted subject to a favorable approval by subsequent letter ballot of Committee D-2.[1]

On motion, the report of the committee, as revised, was adopted.

The report of Committee D-4 on Road and Paving Materials was presented by the chairman, R. W. Crum. The recommendation that the proposed Tentative Specifications for Portland-Cement Concrete for Pavements and Pavement Base be accepted for publication as tentative, after discussion, was rejected by a vote of 1 affirmative and 8 negative.

The proposed Tentative Specifications for Gravel for Bituminous Concrete Base were accepted for publication as tentative.

The proposed revisions of the following three standard specifications were accepted for publication as tentative:

For Block for Granite Block Pavements (D 59 - 26);
For Block for Recut Granite Block Pavements (D 131 - 23);
For Block for Durax Granite Pavements (D 132 - 23).

The proposed revisions of the Tentative Specifications for Broken Stone for Waterbound Base (D 190 - 24 T) and for Broken Stone for Bituminous Concrete Base (D 193 - 24 T) were accepted, the specifications being continued as tentative.

The following four tentative specifications and one method of test were approved for reference to letter ballot of the Society for adoption as standard:

Specifications for Sand for Sheet Ashpalt and Bituminous Concrete Pavements (D 162 - 23 T);
Specifications for Broken Stone for Waterbound Macadam Surface Course (D 191 - 24 T);
Specifications for Broken Stone for Bituminous Macadam (D 192 - 24 T);

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[1] The subsequent letter ballot on this recommendation resulted in 50 affirmative and no negative votes, 31 members failed to return their ballots.

Specifications for Broken Stone for Bituminous Concrete Surface (D 194 - 24 T);

Method of Test for the Determination of Moisture Equivalent of Subgrade Soils in the Field (D 220 - 25 T).

The proposed withdrawal of the Tentative Specifications for Natural or Artificial Sand-Clay Mixtures for Road Surfacing (D 67 - 23 T) and the Method of Test for Quantity of Clay in Sand-Clay, Topsoil and Semi-Gravel for Highway Construction (D 73 - 20 T) was approved.

On motion, the report of the committee was adopted.

A paper entitled "The Effect of the Mixing Temperature on the Physical Properties of an Oil Asphalt in a Sheet Asphalt Mixture" under the joint authorship of J. H. Bateman and H. L. Lehmann, in the absence of the authors was presented by Prévost Hubbard, and discussed.

The report of Committee D-9 on Electrical Insulating Materials in the absence of the chairman, H. S. Vassar, was presented by the vice-chairman, Dean Harvey. The tentative revisions of the Standard Methods of Testing Molded Insulating Materials (D 48 - 27) recommended in 1927 and 1928 were approved for reference to letter ballot of the Society for advancement to standard. The report of the committee as preprinted had also recommended revisions for immediate adoption in Sections 7, 10, 22, 23 and 24 of Methods D 48. The committee recommended that these revisions be made immediately with the exception of the one recommended in Section 23. This recommendation was accepted and the revisions unanimously approved for reference to letter ballot of the Society for adoption as standard, this recommendation requiring a nine-tenths vote. The proposed revision in Section 23 was accepted for publication as tentative subject to a subsequent favorable letter ballot of Committee D-9.[1]

The committee recommended that a modification be made in Fig. 2 showing the thief for sampling tank cars of the proposed tentative revision of the Standard Methods of Testing Electrical Insulating Oils (D 117 - 27). Figure 2 as preprinted illustrated a patented thief and the change in this figure was made in order to show a thief not covered by a patent. With this modification the proposed revision was accepted for publication as tentative.[2]

The proposed revisions of the following six tentative methods of test were accepted for publication, the methods being continued as tentative:

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[1] The subsequent letter ballot on this recommendation resulted in 32 affirmative and 1 negative votes with 8 members not voting.

[2] The subsequent letter ballot on this recommendation resulted in 37 affirmative and no negative votes with 3 members not voting.

Testing Insulating Varnishes (D 115 – 28 T);
Testing Electrical Porcelain (D 116 – 28 T);
Testing Cable Splicing and Pothead Compounds (D 176 – 25 T);
Testing Untreated Insulating Paper (D 202 – 28 T);
Test for Surface Resistivity and Volume Resistivity of Solid Insulating Material (D 257 – 26 T);
Testing Varnished Cloth Tapes (D 295 – 28 T).

On motion, the report of the committee, as revised, was adopted.

The session then adjourned till 8 p. m.

ELEVENTH SESSION—THURSDAY, JUNE 27, 8 P. M.

On Non-Ferrous Metals, General

(Held simultaneously with the Twelfth Session)

President G. W. Thompson in the chair.

The report of Committee B-1 on Copper Wire was presented by the chairman, J. A. Capp. The Tentative Specifications for Bronze Trolley Wire (B 9 – 27 T) were approved for reference to letter ballot of the Society for adoption as standard. On motion, the report of the committee was adopted.

The report of Committee B-4 on High-Temperature and Electrical-Resistance Alloys was presented by the chairman, Dean Harvey. The proposed Tentative Accelerated Life Test for Metallic Materials for Electrical Heating was accepted for publication as tentative. The proposed revision of the Tentative Methods of Chemical Analysis of Metallic Materials for Electrical Heating (B 71 – 27 T) was accepted, the methods as revised being continued as tentative. The proposed revision of the Tentative Method of Test for Resistivity of Metallic Materials for Electrical Heating (B 63 – 26 T) was accepted and the methods as revised were approved for reference to letter ballot of the Society for adoption as standard. On motion, the report of the committee was adopted.

A paper entitled "Life Tests on Metallic Resistor Materials for Electrical Heating" under the joint authorship of F. E. Bash and J. W. Harsch was presented by Mr. Bash, and discussed.

The report of Committee B-2 on Non-Ferrous Metals and Alloys was presented by the chairman, William Campbell. In addition to the recommendations appearing in the report that certain tentative standards be continued as tentative the committee recommended on the floor of the annual meeting that the Tentative Specifications for Rolled Zinc (B 69 – 27 T) be advanced to standard without revision and that the Tentative Specifications for Silver Solders (B 73 – 28 T) be revised as follows and advanced to standard:

Section 8.—Change the third, fourth and fifth sentences to read as follows by the addition of the italicized words and the omission of the words in brackets:

Samples from wire, sheet or strip shall be taken by shearing or clipping pieces from the entire cross-section of the same, remelting in a clean container at a temperature slightly above the melting range, mixing thoroughly, and pouring into a cold mold of convenient size for milling, [or] drilling *or sawing.* The sample so prepared shall be milled, [or] drilled *or sawed* in such a manner as to represent the entire cross-section. [All samples shall be clean and free from dirt, oil, oxide or other foreign material.] *The saw, drill, cutter or other tool used shall be thoroughly cleaned. No lubricant shall be used in the operation, and the sawings or metal chips shall be carefully treated with a magnet to remove any particles of steel introduced in taking the sample.*

Section 9.—Change from its present form: namely,

9. In the case of dissatisfaction, the solder shall be sampled in the presence of representatives of both the manufacturer and the purchaser. The thoroughly mixed sample shall be divided into three equal parts, each of which shall be placed in a sealed package, one for the manufacturer, one for the purchaser, and one for an umpire, if necessary.

to read as follows:

9. In the case of disagreement, the solder shall be re-sampled in the presence of the manufacturer and purchaser. The sample shall consist of not less than 3 oz. of solder prepared as described in Section 8. The thoroughly mixed sample shall be divided into three equal parts, each of which shall be placed in a sealed package, one for the manufacturer, one for the purchaser, and one for an umpire, if necessary.

Section 12.—Change this section to read as follows by the addition of the italicized words:

12. All wire, sheet and strip shall be *reasonably* smooth and bright and *substantially* free from slivers, splitting, or other injurious or objectional defects.

Section 13.—Change this section to read as follows by the addition of the italicized words:

13. Granular solder shall be *substantially* free from oxide, dirt, or any foreign material which will impair its working qualities.

The two specifications were unanimously approved for reference to letter ballot of the Society for adoption as standard subject to the approval by favorable subsequent letter ballot of Committee B-2.[1]

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[1] The subsequent letter ballot on this recommendation resulted as follows: Tentative Specifications for Rolled Zinc, 64 affirmative and no negative votes with 20 members not voting; Tentative Specifications for Silver Solders, 61 affirmative and no negative votes with 23 members not voting.

The report of Sub-Committee XV on Die-Cast Metals and Alloys was presented by the chairman, H. A. Anderson. A paper entitled "Report of Microscopic Analysis of Specimens of Die-Cast Alloys," was presented from manuscript by the author, Mr. E. H. Dix, Jr., and accepted for publication as Appendix II of the B-2 report.

On motion, the report of the committee, as revised, was adopted.

A paper entitled "Aluminum Alloys for Pressure Die Castings," was presented by the author, Sam Tour, and discussed.

The report of Committee B-7 on Light Metals and Alloys, Cast and Wrought, in the absence of the chairman, J. B. Johnson, was presented by vice-chairman, E. H. Dix, Jr. Due to the fact that this committee had just been recently organized a letter ballot on the recommendations contained in the report of the committee had not been conducted in the usual manner. It was accordingly recommended that the report with the recommendations contained therein affecting standards be adopted subject to a favorable letter ballot of Committee B-7. Accordingly, the Tentative Specifications for Aluminum Ingots for Remelting (B 24 – 26 T) and for Aluminum Sheet (B 25 – 26 T) were approved for reference to letter ballot of the Society for adoption as standard.[1] On motion, the report of the committee was adopted subject to the favorable letter ballot of Committee B-7.[2]

A paper entitled "Fatigue Resistance on Some Aluminum Alloys" under the joint authorship of J. B. Johnson and T. T. Oberg, in the absence of the authors, was presented by title and discussed.

A paper entitled "The Effect of Corrosion, Accompanied by Stress, on the Tensile Properties of Sheet Duralumin," by H. S. Rawdon was presented by the author, and discussed.

The meeting then adjourned till the following morning.

TWELFTH SESSION—THURSDAY, JUNE 27, 8 P. M.

Symposium on Mineral Aggregates

(Held simultaneously with the Eleventh Session)

Mr. H. S. Mattimore in the chair.

The Symposium on Mineral Aggregates was introduced by R. W. Crum who stated that for several years various organizations have been struggling with the problem of standardizing specifications for mineral aggregates, especially for concrete use, and in dealing with them over this period of time, we had come to a general realization of the fact that a great deal to do with mineral aggregates is a matter of local conditions and that standardization to any fine degree on a national scale is probably impracticable. What is needed to go with such specifications is a body of sound information concerning the facts of the different characteristics of these materials under different conditions of use. It was with this thought in mind that the committee appointed to act in an advisory capacity to the Committee on Papers and Publications had gathered together a number of papers to take stock of the situation, see what the present knowledge and status of this subject is and to look ahead and make some note of the information that is badly needed.

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[1] The letter ballot on this recommendation resulted as follows: Tentative Specifications for Aluminum Ingots for Remelting, 15 affirmative and no negative votes with 8 members not voting; Tentative Specifications for Aluminum Sheet, 16 affirmative and no negative votes with 7 members not voting.

[2] The report was submitted to letter ballot of the committee, which consists of 25 members; 23 members returned their ballots, of whom 15 have voted affirmatively and none negatively.

A paper entitled "Methods of Inspection of Mineral Aggregates," by A. S. Rea was then presented by the author and discussed.

The subject of fine aggregate in concrete and in mortar and plaster was covered in the following two papers:

"Fine Aggregate in Concrete," by H. F. Gonnerman—presented by the author;

"Fine Aggregate in Mortar and Plaster," by J. C. Pearson—presented by the author.

The presentation of these papers was followed by discussion.

The subject of fine aggregate in bituminous mixtures was covered in the following two papers which were followed by discussion:

"Fine Aggregate in Bituminous Mixtures," by H. W. Skidmore, in the absence of the author was presented by M. H. Ulman;

"Effect of Aggregates upon Stability of Bituminous Mixtures," by Prévost Hubbard—presented by the author.

The meeting adjourned till the following morning, the symposium being continued in the Thirteenth Session.

THIRTEENTH SESSION—FRIDAY, JUNE 28, 9.20 A. M.

Symposium on Mineral Aggregates (continued from Twelfth Session)

(Held simultaneously with the Fourteenth Session)

Mr. R. W. Crum in the chair.

This session consisted of a continuation of the Symposium on Mineral Aggregates which had been opened in the Twelfth Session with a detailed discussion of methods of inspection of mineral aggregates and their effect on concrete, plaster and bituminous mixtures. The second section of the symposium consisted of a discussion of the influence of the quality of coarse aggregate on the strength and durability of concrete and the fire resistance of concrete, on aggregates for untreated roads and for sewage disposal and railroad ballast, and on needed research in mineral aggregates, as follows:

"Influence of Quality of Coarse Aggregate on Strength of Concrete," by F. C. Lang—presented by the author;

"Influence of Coarse Aggregate on the Durability of Concrete," under the joint authorship of F. R. McMillan and G. W. Ward—presented in the absence of the authors by H. F. Gonnerman;

"Influence of Mineral Composition of Aggregates on Fire Resistance of Concrete," by S. H. Ingberg—presented by the author;

"Aggregates for Low-Cost Untreated Roads," by C. N. Conner—presented by the author;

"Mineral Aggregates for Sewage Disposal and for Railroad Ballast," by H. F. Kriege—presented by the author;

"Needed Research in Mineral Aggregates," by F. H. Jackson—presented by the author.

The papers were discussed individually as presented. The session was then thrown open for general discussion.

The meeting then adjourned till 8 p. m.

FOURTEENTH SESSION—FRIDAY, JUNE 28, 9.30 A. M.

On Non-Ferrous Metals: Copper and Copper Alloys, Metallography

(Held simultaneously with the Thirteenth Session)

Past-President H. F. Moore in the chair.

The report of Committee B-5 on Copper and Copper Alloys was presented by the chairman, C. H. Mathewson. The advancement to standard of the tentative revisions of the following standards was approved for reference to letter ballot of the Society for adoption:

Standard Specifications for Cartridge Brass (B 19 – 19);
Standard Specifications for Cartridge Brass Disks (B 20 – 19);
Standard Specifications for Seamless Admiralty Condenser Tubes and Ferrule Stock (B 44 – 24);
Standard Specifications for Free-Cutting Brass Rod for Use in Screw Machines (B 16 – 18);
Standard Specifications for Naval Brass Rods for Structural Purposes (B 21 – 27).

On motion, the report of the committee was adopted.

A paper entitled "Physical Properties and Methods of Test for Some Sheet Non-Ferrous Metals" under the joint authorship of J. R. Townsend, W. A. Straw and C. H. Davis was presented by Mr. Townsend and discussed.

A paper entitled "Fatigue Studies of Non-Ferrous Sheet Metals" under the joint authorship of J. R. Townsend and C. H. Greenall was presented by Mr. Townsend and discussed.

A paper entitled "Hardness Relationships and Physical Properties of Some Copper Alloys" under the joint authorship of C. H. Davis and E. L. Munson was presented by Mr. Davis and discussed.

A paper entitled "Bearing Bronzes With and Without Zinc" under the joint authorship of H. J. French and E. M. Staples was presented by Mr. French and discussed.

The report of Committee E-4 on Metallography was presented by the chairman, H. C. Boynton. The recommended advancement to standard of the Tentative Recommended Practice for Radiographic Testing of Metal Castings (E 15 - 26 T) was approved for reference to letter ballot of the Society for adoption. On motion, the report of the committee was adopted.

A paper entitled "An X-ray Study of Copper Which Showed Directional Properties on Cupping" under the joint authorship of Arthur Phillips and Gerald Edmunds was presented by Mr. Edmunds and discussed.

The meeting then adjourned till 8 p. m.

FIFTEENTH SESSION—FRIDAY, JUNE 28, 8 P. M.

On Cement and Concrete

Mr. W. H. Klein in the chair.

President G. W. Thompson opened this session with remarks by way of valedictory, referring to the fact that the annual meeting had been very successful not only because of a record attendance but also because of the activities of the committees, the quality of the technical papers and particularly the individual interest shown by the members. He mentioned that the success of the Society is primarily due to the activities of the committees and to those things which the committees accomplish; the weaknesses of the Society are those things which are left undone. The President expressed once more his appreciation of the honor bestowed upon him by the Society and wished that the coming year would be even more successful than the past.

The report of Committee C-1 on Cement was presented by the chairman, P. H. Bates. Mr. Bates announced that Committee C-1 had held three very well attended meetings during the annual meeting to consider two matters not mentioned in the report of the committee as preprinted. The first was tolerances for apparatus used in testing cement and the other a revision of the Standard Specifications for Portland Cement (C 9 – 26) involving a modification of the existing strength requirements for portland cement and the addition of new requirements for high-early-strength portland cement. These matters had been approved by the committee for submission to letter ballot of the committee. On motion, the report of the committee was adopted.

The winners of the Golf and Tennis Tournaments were then announced and the prizes were awarded by E. D. Boyer on behalf of G. H. Clamer, chairman of the Entertainment Committee. The A.S.T.M. championship golf cup for low score was won for the second consecutive year by H. G. Farmer of Pittsburgh, Pa. The A.S.T.M. championship tennis cup was likewise won for the second consecutive year by F. S. Crane of Chicago, Ill.

Other prize winners in golf and tennis were: J. G. Bragg, W. C. Hammond, J. B. Davis, E. D. Boyer, H. F. Clemmer, G. E. Warren, P. H. Cathcart, G. F. Schlesinger and G. C. Wilsnack.

On motion it was voted that a vote of thanks be given Mr. Clamer for the very able manner in which he handled the golf and tennis tournaments.

The following papers were presented and discussed:

"The Rate of Hydration of Cement Clinker" under the joint authorship of F. O. Anderegg and D. S. Hubbell—presented by Mr. Anderegg;

A paper entitled "A Compression Test for Portland Cement" by O. L. Moore—presented by the author;

A paper entitled "The Tensile Autogenous Healing of Portland-Cement Mixtures" by H. J. Gilkey—presented by the author.

The report of Committee C-9 on Concrete and Concrete Aggregates was presented by the chairman, Cloyd M. Chapman. The proposed revisions of the Standard Methods of Making and Storing Specimens of Concrete in the Field (C 31 – 27) were accepted for publication as tentative. In presenting the report, the chairman called on A. T. Goldbeck to present the report of Sub-Committee IX on Specifications and Methods of Tests of Aggregates and also a paper entitled "A Digest of Report on Effect of Stone Dust on the Properties of Concrete" appended to the sub-committee report. The report as preprinted stated that the report of the Section on Method of Fabricating Flexure Test Specimens (L. W. Teller, chairman) of Sub-Committee VIII on Field Tests of Concrete would not be ready for inclusion in this year's report. It was found possible, however, to assemble the information on this project for inclusion in the 1929 report and a brief outline of the work was presented by Mr. Teller and the report accepted for publication. Mr. Chapman then called on Stanton Walker to present the paper entitled "Effect of Flat Particles on Concrete-Making Properties of Gravel" under the joint authorship of Stanton Walker and C. E. Proudley. On motion, the report of the committee was adopted.

A paper entitled "Sugar in Sand: A Quick Test to Determine Its Presence Bacteriologically" by N. H. Roy, in the absence of the author was presented by title and discussed.

A paper entitled "Modulus of Elasticity and Poisson's Ratio for Concrete, and the Influence of Age and Other Factors upon These Values" under the joint authorship of R. E. Davis and G. E. Troxell, was presented by H. F. Gonnerman and discussed.

A paper entitled "Tests for Powdered Admixtures in Concrete" by Duff A. Abrams was presented from manuscript by the author and discussed.

There being no further business, the Chair declared the Thirty-second Annual Meeting adjourned *sine die*.

STANDARDIZATION AND GOOD WILL

ANNUAL ADDRESS BY THE PRESIDENT

G. W. THOMPSON

JUNE 26, 1929

The President of the United States, Mr. Herbert Hoover, when he was Secretary of Commerce made many speeches and issued many communications to the public in the general advocacy of standardization. While not attempting to present Mr. Hoover's views in detail, there is one thought that runs through all of his addresses on this subject to which I would direct your attention. In the United States, industries are conducted on a large scale. In order that these industries should be profitable it is necessary, so far as is practicable, that the products manufactured be simplified as to number and kind so that large production of unit types of products can be made day in and day out. In order to do this the products must be standardized to meet the demands of the consumer. The only limitation to this point of view is that the standards should not go so far as to prevent the obtainment by the consumer of materials that are best suited to his needs.

The American Society for Testing Materials is one of the oldest standardizing bodies in our country. While its name indicates that its main purpose is the testing of materials, it has been recognized always that the testing of materials more or less inevitably leads to the preparation of standard specifications for materials which will meet standardized tests. Very naturally this work has been directed toward standard methods of test and standard specifications for engineering materials. The Charter of our Society states that the purpose of the Society is "the promotion of knowledge of the materials of engineering, and the standardization of specifications and the methods of testing."

The form of organization of our Society presupposes several things. The first of these is that there are engineering materials manufactured and consumed in large quantity for which it is to the mutual advantage of both producers and consumers to develop standard specifications and standard methods of test. Therefore, our Society is composed of both the representatives of producers and the representatives of consumers, and our standing committees are presumed to be free from the dominance of either party. The second implication is that our Society is primarily interested in the large consumer, and to a less degree the large producer, simply because it is only these who would feel justified in seeking representation in our Society and on its standing committees. This does not mean that our work omits consideration of the interests of small consumers who inevitably profit through our standardization work. It is only in the first instance that the large consumer is a dominant factor. A third implication is that the standard specifications which our Society may promulgate shall relate to materials which are dealt in in relatively large quantities for the specific purpose for which they are used—for the profitableness of standardization can only be realized under such conditions. By specific purposes we mean that the product standardized for one purpose may be unsuitable for other purposes. There is another implication which is somewhat of a negative character, namely, that our Society should not be expected to function unless both producer and consumer are interested in the specific material for which specifications might be drawn up. This applies more particularly to specifications for materials and not so much to methods of test. How definitely our Society should adhere to this negative principle I am not prepared to say except that in no case should producers alone prepare specifications for any material and, unless the consumer of a particular material used in a particular way is represented upon a standing committee, specifications for that material to be used in that particular way should not be considered by our Society.

While our Society is primarily interested in materials for engineering, it has been willing in the past and I think it will be willing in the future to assist in the formation and in the development of other standardizing agencies which have to handle specifications for materials on a somewhat broader basis than purely engineering materials. Furthermore, while our Society is limited to the standardization of materials for engineering, it has in the past, and I hope it will in the future, lend a helping hand to all other organizations having for their purpose the standardization of products in the more complete form, such as machines or parts of machines. Our Society was instrumental in the organization of the American Engineering Standards Committee, now functioning under the name of the American Standards Association and under that name having a scope practically unlimited. It has representation upon the United States National Committee of the International Electrotechnical Commission and supports its activities although these activities extend far beyond the scope of our Society.

Having now described in general the scope and functions of the American Society for Testing Materials, we come to the important matter of how effectively it has served industry in general and wherein we may be able to serve industry in general more efficiently in the future. However, before speaking definitely on these points I wish to say something upon the question of standards in general. Being an intense individualist, I react with just as great resistance as anyone I know of to any form of standardization which tends to limit individuality and which would tend to make us, as individuals, more or less alike and traveling through the world at the same gait. I speak only for myself and would not presume to speak for anyone else in this Society; but although I am so intense an individualist I have been completely convinced of the wisdom of standardization by means of standard specifications for materials for engineering wherever these are used in relatively large quantities for specific purposes. I am convinced that the economic argument as laid down by Mr. Hoover is unanswerable and I can conceive of no greater service which this Society can render to industry in general than by leading in such standardization. Having expressed myself in this way, permit me to point out the dual aspect of our Society. We are made up of producers and consumers, ignoring for the moment those detached experts who may be considered either or both. I lay down the postulate that the producer owes a duty to the consumer and the consumer owes a duty to the producer as represented in our Society and on our standing committees. This means that neither group must resist unreasonably the demands of the other group. Producers must not resist unreasonably the demands of consumers for standard specifications, and on the other hand, consumers must not be so insistent upon standard specifications as to force producers to acquiesce in them before they are properly developed.

If there ever was a democratic organization in the best sense of the term our Society is one. In theory at least, and actually I believe, our committees are made up of those who have common ends approached from different standpoints. Our committee meetings are in principle those of the Round Table where, while you have nominal chairmen, there is no head nor foot but all sit down at the table with equality. If it ever so happened that our committee meetings became in the nature of the long table with a head and a foot unfortunate it would be for our Society.

What is more, our Society has wide-open doors and if any consumer, or group of consumers, has an interest in the standardization of materials for engineering he finds the spirit of our Society welcoming him as a member, and the same is true with regard to the producers.

Our Society has its responsibilities. We have undertaken the performance of certain work within a more or less restricted field. As a general rule, the course of industrial development follows this general order. There are those in industry who are naturally the ones most adapted to promote progress. If, however, for any particular reason they are restricted in their action it will not stop the progress of industry for the reason that some other instrumentality will come to the front and take up the work which is needed. Therefore, our Society should follow the flow of industrial progress allowing its current to carry it along and performing those functions which would naturally devolve upon it in the course of this flow. If it resists the flow the inevitable result will be that other bodies will take up our work and our Society will suffer thereby.

I think we may as well speak openly about one of the great difficulties that confronts our Society. There are a large number of industrial organizations in this country that are inclined to resist standardization on the ground that it substitutes something for the good will their organizations are trying to build up by the expenditure of large sums of money for advertising. They consider that standardization and the building up of good will are incompatible. To a certain extent I sympathize with this view although my better sense condemns it in so far as it relates to the standards of this Society. So far as consumers are concerned, they have specifications of their own if they are not more generally standardized by a body such as ours. Therefore, standardization by our Society, as it affects the large consumer, substitutes general standards for isolated standards. The large consumer will generally buy in the open market on more or less of a competitive basis. He may have his preferences and he may prefer to give his orders to certain producers, but this depends largely upon other things being equal, such as price and quality of product. I must emphasize here, however, that what I say has relation only to those materials which are bought in relatively large quantities for specific purposes. What I say does not relate to the purchase of small quantities of material for very indefinite purposes which materials have been found by experiment and use to satisfy the needs of the consumer. It is not for me to draw the line between these two groups of materials and their uses but that there is a distinction between them is clear. Of course, specification of materials used in large quantities will also cover the use of these materials in small quantities, which is of advantage to the general public.

Let us think on the other hand as to the effect upon the producer and the good will he is endeavoring to build up when he has a record of having furnished some standard product to a large consumer year in and year out with extreme satisfaction to the consumer. It is presumed that the consumer has examined carefully the products delivered to him by this producer. The weights and volumes have been checked, analyses have been made of the product, and this product has been uniformly found to conform to standard specifications. Does this add anything to the value of the good will of the producer? I am sure it does add a great deal to that value. Let me emphasize again, however, that standard specifications without a proper inspection of deliveries under the specifications may work injustice to the reliable producer who has been underbid by someone less reliable.

All consumers naturally want to buy in the cheapest market. This desire exists whether there are standard specifications or not. Suppose there are no standard specifications, what will the consumer do? He will buy in the cheap market just the same but he will be far more subject to those blandishments of the salesmen with which we have in the past been too familiar. He may tie himself up to a producer of good reputation but he cannot close his eyes then to the price that he has to pay. He will take such steps as he may think proper to find out what a similar product can be purchased for from others, and he may institute tests to give him some idea of their relative value. Uncertainty and doubt will often flood his mind.

It is said that standard specifications are often compromises. As a statement of fact this is undoubtedly true. As a basis of criticism it is unsound. A standard specification, whether it is good or bad, has only the same kind of value which attaches to everything else. It is good or bad according to the way it works. All specifications, when we study the history of them, began with what are called "bad specifications," or, as some would say, imperfect specifications, using what I consider a very improper designation. It is the order of progress that what we did yesterday should be bad and imperfect as compared with what we do to-day, but we must remember that what we do to-day is based upon what we did yesterday. Standard specifications are not fixed things; they are constantly subject to change. They should not be adopted prematurely, neither should they be amended prematurely, but they should show constant growth. In our Society, with our standing committees made up of both producers and consumers constantly studying the problems covered by specifications, there is a quick response as to the efficiency of specifications. Sometimes producers and sometimes consumers will not use specifications. Time only can tell whether they are right or whether they are wrong. As to the criticism that standard specifications are usually compromises, that we admit and we admit it cheerfully in that we do not know of anything in life that is not a compromise. I may be or may not be willing to admit that there are such things as absolute principles which govern all cases, but I know of no case where an absolute principle can be applied without compromise in the ordinary affairs of life. We are compelled every day, if we are really conscientious and desire to do the best that we can under the circumstances, to compromise. We make compromises every day and we see how they work and we should be ready to amend these compromises from day to day with the desire to get the re-compromised proposition in better shape. We cannot do more than this.

Permit me to sum up this talk with these few words. Our Society occupies an impregnable position, impregnable so long as we perform our functions rationally, justly, and with a continuous process of development. We have no desire to break down any good structure in industrial life. Our object is to build as far as we can on sound foundations, going only as far and as fast as we feel that the circumstances justify. We aim to move constantly forward, requiring no push or prod, for our aims are clear and our methods of procedure have stood the test of time. If, however, our Society would live up to its great purpose none of its members and none of its committees must stand in the way of general progress along the lines of proper development. I trust that our future will far exceed in brilliance our past in the service which we are rendering to industry, to our country, and to the world at large.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE

Summary:

The year closing with this annual meeting has been an active one in Society affairs. There has been a net gain in membership during the year of 52, bringing the total membership on June 1 to 4244. We are still experiencing some effects of readjustment incident to the increase of company membership dues to $30; but it is believed that this period of adjustment is about to close and that from now on the curve of membership growth will again turn definitely upward. A five-year program of membership extension work has been inaugurated which contemplates district membership committees in all of the principal industrial communities of the country. Committees in the Detroit and Chicago-Milwaukee districts have been organized and one in the Cleveland district is planned. Similar committees on the Pacific Coast have been organized in the Los Angeles, San Francisco and Seattle districts.

The finances of the Society are in a sound condition. The surplus at the close of the fiscal year, December 31, 1928, was $40,504.70, in addition to which there are special funds in the sum of $10,354.30 covering Life Membership Fund, A.S.T.M. Research Fund, Headquarters Fund and Publications Fund; and $6057.80 is being held as reserve for the 1930 Book of Standards. Investments of Society funds total $44,752.09. The A.S.T.M. Research Fund has reached a total of $6400, having been practically doubled in a year. It is of interest to note that the added income from increased company membership dues, which in 1928 was approximately $15,000, was used one-third for Publications, one-fourth for Headquarters Reserve, one-tenth for the Research Fund and one-fifth in building up the technical staff of the Society.

The five-year lease upon the quarters now occupied by the Society in the building of the Engineers' Club of Philadelphia expires at the close of this year. In view of plans that the Engineers' Club now has under consideration for new or rehabilitated headquarters, it is being arranged to extend the Society's lease on its present quarters for the limited period of two years.

The regular publications of the Society for 1928 comprise 2687 pages, not including the 1928 Book of Tentative Standards (932 pages) furnished to members on order at special prices. The Index to A.S.T.M. Standards and Tentative Standards is a new publication made possible largely by the increased income of the Society through company membership dues. It will be published annually hereafter and should greatly facilitate reference to the standard and tentative specifications, tests and definitions of the Society. The annual report of Committee E-6 on Papers and Publications will cover matters relating to the printing of reports and papers for this meeting.

The committees of the Society have been quite active during the year and an examination of their reports will show much progress in the development of new standards and in the carrying on of investigations. In this connection the annual report of Committee E-9 on Correlation of Research contains a useful summary of the research activities of committees and joint committees of the Society.

Three new standing committees have been formed during the year, namely, Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, Committee B-5 on Copper and Copper Alloys, Cast and Wrought, and Committee B-7 on Light Metals and Alloys, Cast and Wrought. An important realignment of committee activities in the non-ferrous metals group is being made involving the formation of a Coordinating Committee on Non-Ferrous Metals and Alloys, which constitutes a new development in the administration of committee affairs in the Society. A somewhat similar Coordinating Committee on Corrosion has been formed to correlate the corrosion studies of the four committees of the Society dealing with this subject. A new Research Committee on Fatigue of Metals has been formed. Committee C-1 on Cement has sponsored the establishment at the U. S. Bureau of Standards of a Reference Laboratory for Standard Cement Testing which is being financed jointly by the United States Government and the Portland Cement Industry.

The Spring Group Committee Meeting was held for the first time in the Middle West with a meeting in Chicago, March 19 to 22. Twenty-five committees of the Society participated, the meetings of these committees and of sub-committees totaling 93. The registered attendance was 375, indicating that very successful meetings can be held at such locations as well as in the East. For the first time the railroads granted reduced convention rates on the Certificate Plan, thus effecting a considerable saving for those members coming from a distance.

Changes are being suggested this year in the Regulations Governing Standing Committees and in the By-laws in order to expedite the promulgation of tentative standards, making it possible to accept tentative standards in the interim between annual meetings. A new Committee E-10 on Standards is being organized, one of the functions of which will be the review of tentative standards submitted between annual meetings. It will be the further function of this committee to review the general standardization activities of the Society. The procedure that is being proposed in respect to the earlier submission of tentative standards will in no way affect the present safeguards that surround the formal adoption of A.S.T.M. standards, but at the same time it is expected to speed up materially the development and publication of tentative standards. The details of the procedure are referred to later in this report as well as in the current report of Committee E-5 on Standing Committees.

The necessary amendments of the By-laws entailed in the adoption of the new procedure are presented in this report, together with other amendments of the By-laws looking toward the enlargement of the Executive Committee so as to permit more frequent representation in the administration of the Society of all interests covered in the field of the Society's activities.

The steps that have been taken in building up the administration of standardization work are evidences of the Executive Committee's policy to strengthen the Society and extend its influence and value. The visit of the Secretary-Treasurer to the Pacific Coast is another example. The Society's influence has extended far and wide, resulting in a membership not only national but international. It is the intention that this widespread membership be an active one, participating to the greatest extent possible in all of the Society's activities. It is to this end that the visit of the Secretary-Treasurer was made in order to bring the West Coast members more intimately in touch with the Society's affairs and to devise ways in which the members may participate in the Society's activities to better advantage. Some recent developments that are the outgrowth of this visit are referred to later in this report.

The Society has continued in its cordial relations with other societies participating in joint committees or in joint actions with the representatives of many of these other organizations serving on its standing committees. Its work under the American Standards Association (formerly the American Engineering Standards Committee) has continued to grow and is referred to in some detail later in this report. Reference is also made to the relations of the Society with the work of simplification and standardization of the Department of Commerce. The Society is cooperating with the New International Association for Testing Materials in the development of the program for the next International Congress to be held in Zurich in 1931.

Membership:

The membership of the Society on June 1, 1929, was 4244 compared with the membership on the corresponding date, 1928, of 4192. Statistics for the year are shown in the following table:

Class of Members	Membership		Losses				Additions		Totals		
	June 1, 1928	June 1, 1929	Resignations	Dropped	Death	Transfer	Transfer	Elections	Loss	Gain	Increase
Honorary	4	4	..	..	..	..	..	..	..	..	..
Life or Perpetuity	11	11	..	..	1	..	1	..	1	1	..
Company, Firm, etc	1155	1153	62	33	..	6	5	94	101	99	2[a]
Individual, etc	2968	3018	102	86	20	6	25	239	214	264	50
Junior	54	58	2	7	..	19	..	32	28	32	4
Total	4192	4244	166	126	21	31	31	365	344	396	52
Student	213	260	9	54	1	14	..	125	78	125	47

[a] Decrease.

It will be seen from the table that the Society is still experiencing some effects of readjustment from the establishment on January 1, 1928, of dues of $30 for companies, firms, corporations, industrial associations and commercial testing laboratories. The number of company members reported a year ago included nearly 100 who up to that time had not indicated whether they would continue to retain their status as company members. Slightly over half of these have retained their company membership, about one-third were dropped for non-payment of dues and the remainder transferred to individual membership; so that of the 1581 companies, firms, corporations, industrial associations and commercial testing laboratories that were members when the increased dues were made effective, 975 (about 60 per cent) have retained their corporate membership, 390 (about 25 per cent) have transferred to individual membership, and the remaining 216 have resigned or have been dropped for non-payment of dues. The losses in company members have been partially offset by the election of new companies, firms and associations into the Society, so that the number of such members, 1153, on June 1, 1929, is practically the same as a year ago. This is considered on the whole to be a very satisfactory showing during this period of readjustment.

The number of new members for the year, 365, is slightly greater than for the preceding year, although not so large as that of two and three years ago. It has, however, definitely turned upward again the curve of membership growth (see Fig. 1) with a net increase in membership of 52.

Progress has been made in the development of Student Membership. Efforts this year were confined to the same thirty or so engineering and technical schools originally approached to interest their technical students in this grade of membership and there has been a net gain during the year of 47, bringing the total Student Membership to 260. It will be of particular significance to observe the percentage of student members who upon graduation from their school transfer to Junior Membership. There has been but one graduation period since this class of membership was inaugurated, at which time 70 Student Members graduated from their schools. Thirteen of these, or nearly 20 per cent, transferred to Junior Membership, which is found to compare reasonably well with the experience of other technical societies that have had student membership on a comparable basis for some years.

The Society has suffered loss by death of the following 21 members:

	DATE OF MEMBERSHIP		DATE OF MEMBERSHIP
Angus, David	1925	Foucar, E. L.	1912
Annan, A. H.	1913	Fuller, J. W.	1908
Bixby, W. H.	1903	Humphrey, Richard L.	1896
Boardman, J. W.	1915	Jones, Jesse L.	1909
Brownfield, W. A.	1925	Lyons, G. H.	1923
Burt, H. J.	1911	Maxwell, A. R.	1924
Cooper, W. J.	1927	Miller, S. W.	1917
Danielson, A. G.	1924	Porter, J. Madison	1898
Dewar, John	1908	Robinson, A. F.	1904
D'Olier, W. L.	1912	Salamon, M. S.	1925
Eidlitz, O. M.	1904		

A number of these members had been connected with the Society for many years and some had been quite active in its affairs. Richard L. Humphrey was the first secretary (1898–1900) of the American Section of the International Association for Testing Materials and had served on many of the Society's committees, including the Committees on Cement and on Reinforced Concrete, having been for many years secretary of the former and from 1917 to the time of his death chairman of the latter. J. Madison Porter was the second secretary (1900–1902) of the American Section, I.A.T.M., and maintained for many years an active interest in Society affairs. Gen. W. H. Bixby was one of the life members of the Society; he was a member of the Executive Committee from 1913 to 1915, Vice-President 1915 to 1916 and President 1917. J. L. Jones and A. F. Robinson were particularly active in the committee work of the Society. Appropriate obituary notices have been included in the issues of the A.S.T.M. Bulletin.

Program of Membership Extension:

The importance of healthy growth in membership has been frequently emphasized by the Executive Committee. Increased membership stimulates Society activities through supplying new workers for our committees, in extending the usefulness of Society standards by their wider dissemination and in providing added financial support. An active organization attracts new members by the very force of its work and accomplishments, and the Executive Committee has considered it a matter of primary importance to bring the Society's accomplishments and activities to the attention of all who might profit through closer contact with this work.

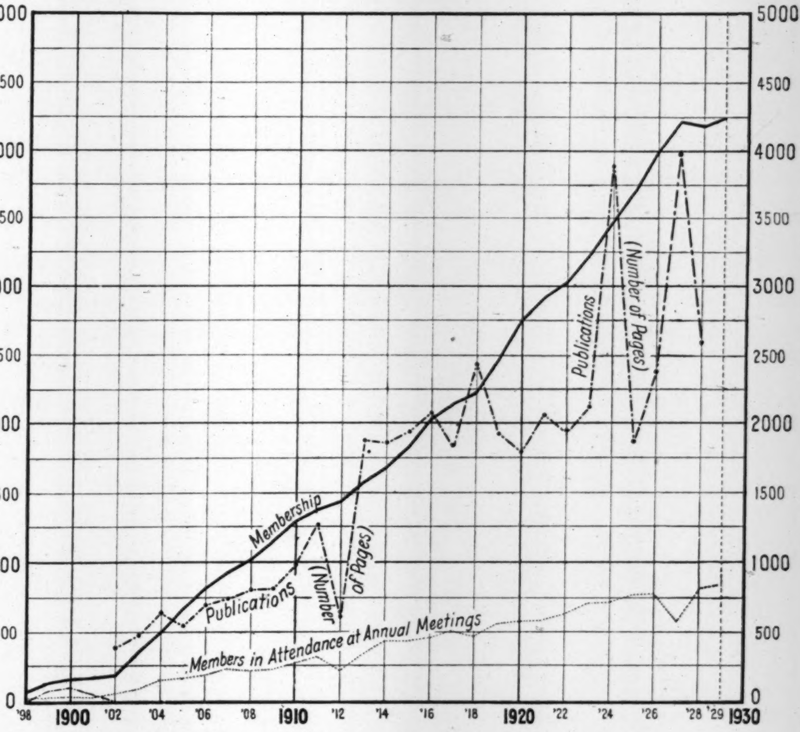

FIG. 1.—Membership and Publications Chart.

For the past six years the Executive Committee has enlisted the aid of the standing committees of the Society in building up the membership. The committees responded splendidly and in that period have been the means of bringing in approximately 875 new members. Recent studies of Society membership in comparison with the population and industrial status of the nine census zones of the country have suggested the desirability of undertaking promotional work for the next five years on the basis of district committees of members established in the principal industrial centers, each committee to function for approximately a two-year period.[1] Within the past two months two such committees have been organized, one in the Detroit district under the chairmanship of F. O. Clements of the General Motors Corporation, and the other in the Chicago-Milwaukee district under the chairmanship of John Brunner of the Illinois Steel Co. The organization of a third committee in the Cleveland district is to be undertaken later in the year, and possibly a fourth in the Cincinnati district, thus covering the East-North-Central Zone (Ohio, Indiana, Illinois, Michigan and Wisconsin), which is the second largest industrial zone, being second only to that in which the Society has its headquarters, the Middle Atlantic Zone (New York, New Jersey and Pennsylvania).

Similar district committees have also been organized on the West Coast: one in the Los Angeles district under the chairmanship of Prof. F. W. Hinrichs, Jr., California Institute of Technology; one in the San Francisco district under the chairmanship of A. A. Hanks, President A. A. Hanks, Inc.; and one in the Seattle district under the chairmanship of Prof. I. L. Collier, University of Washington. While these committees have been organized for somewhat broader purposes as a result of the visit of the Secretary-Treasurer on the Pacific Coast last fall, they will also serve as membership extension committees. These, together with a fourth that may be organized in the Portland (Ore.) district, will provide for the development of this work in the Pacific Coast Zone.

Announcement of the personnel and other details of these committees will be made from time to time in the A.S.T.M. Bulletin.

The Executive Committee will look for the continued assistance of the standing committees and of individual members in building up and maintaining a strong, active membership, such as is needed to carry on the vitally important work of the Society.

A.S.T.M. Committee Activities:

Since the last annual meeting the following three new standing committees have been organized: Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys; Committee B-5 on Copper and Copper Alloys, Cast and Wrought; and Committee B-7 on

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[1] The details of the comparison referred to for each of the nine census zones of the country were published in the A.S.T.M. Bulletin for April 30, 1929, p. 3.—ED.

Light Metals and Alloys, Cast and Wrought. The steps leading to the organization of Committee A-10 were outlined in the annual report of a year ago. This committee has had assigned to it a most important group of alloys, in which there is much need of coordinated research in the corrosion resistance and other properties of these alloys. In the organization of this committee it has been necessary to consider the relationship of its field of work to that of Committee B-4, originally entitled Metallic Materials for Electrical Heating, which deals with a portion of the alloys in the iron-chromium-nickel system used especially for electrical heating purposes. Committee B-4 having requested that its scope be enlarged to include electrical resistance alloys, its title was changed to High-Temperature and Electrical-Resistance Alloys. Some questions of jurisdiction between the two committees are still under consideration and are expected to be adjusted shortly.

The organization of the new Committees B-5 and B-7 is part of a realignment of committee activities in the non-ferrous metals committee group that has come about through recommendations made by Committee B-2 on Non-Ferrous Metals and Alloys, which proposed that certain parts of its work that had grown quite large and were more or less unrelated to other parts be transferred to three new committees, continuing the general non-ferrous standardization work in Committee B-2. Committee B-5 has therefore taken over the activities of Committee B-2 in investigation and standardization of copper and copper alloys, and Committee B-7 has similarly been given jurisdiction over the light metals and alloys. The third group thus to be transferred is that of the tin, lead and zinc-base alloys. The organization of Committee B-6 on this subject has been authorized but has not yet been completed, so that this subject still remains in the jurisdiction of Committee B-2. The latter committee continues its jurisdiction over the pure metals in ingot form, non-ferrous alloys for railway equipment, metallic fluxes and deoxidizers, strip zinc, silver and gold solders, die-cast metals and alloys, and methods of chemical analysis, methods of testing and nomenclature.

Activities in the field of non-ferrous metals and alloys have grown steadily for a number of years and this fact, coupled with the decision to organize new committees in that group, has led to the formation of a Coordinating Committee on Non-Ferrous Metals and Alloys, which is to be made up of two representatives from each of the committees in the B group. While this committee is to derive its powers from the standing committees represented on it, it is planned that one of its most important functions will be the coordination of activities of the non-ferrous metals committees, adjusting questions of scope and jurisdiction, taking care of possible overlaps in the committees' activities and providing for joint work where necessary. It is believed, too, that this committee can be developed into an important administrative committee, guiding and directing the activities of the Society in the whole non-ferrous metals field and in particular can be of valuable assistance in the planning of annual meeting programs and discussions on topics in that field. This is a new development in the administration of committee affairs in the Society. The committee was formally organized during the year and will hold its next meeting during the coming annual meeting.

A Coordinating Committee on Corrosion functioning along somewhat similar lines has been formed to correlate the corrosion studies of the four committees of the Society that are dealing with this important subject as applied to different groups of materials, namely, Committees A-5 on Corrosion of Iron and Steel, A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, B-3 on Corrosion of Non-Ferrous Metals and Alloys, and B-4 on High-Temperature and Electrical-Resistance Alloys. Each committee has appointed two representatives on the Coordinating Committee. A study of corrosion as applied to the whole field of metals and alloys is so large and so complicated that it has seemed quite impracticable to assign the entire field to one committee. Each of the four committees above named, working in the field assigned to it, will have all the work that it can reasonably be expected to handle; nevertheless their fields do touch and to some extent may overlap in important ways, and the Coordinating Committee has been formed to provide an official means of contact and coordination of activities between the committees.

With these three new standing committees, each of which is presenting a report at this annual meeting, the number of standing committees is brought to 48. For the most part the committees have actively carried forward their work during the year and 42 of them are presenting reports at this meeting. Many of the reports record substantial progress in investigations under way in the committees and in the promulgation of new and revised standards for materials. Thus the committee reports include 20 new tentative standards, 28 tentative revisions of existing standards, 26 revisions of tentative standards, the advancement of 32 tentative standards to standard, the advancement to standard of 19 revisions of existing standards, and the withdrawal of 9 standards and tentative standards. There are at present 548 standards and tentative standards of the Society and if the recommendations of the various committees are approved this number will become 563.

The reorganization of Committee C-4 on Clay and Cement-Concrete Pipe has been effected along lines suggested by the Executive Committee, having in mind in part the development of specifications for concrete culvert pipe and reinforced-concrete sewer pipe. The significant feature of the reorganization is the division of the committee activities between two sub-committees, one dealing with clay pipe and the other with cement-concrete pipe. Changes in and additions to the membership of the committee are being made. In the course of this reorganization, consideration was given to a plan of combining Committee C-4 and Committee C-6 on Drain Tile in one committee dealing with all non-metallic pipe and tile. It was decided, however, that it would be best to continue the two committees with jurisdiction over their respective fields. The Executive Committee has referred to Committee C-4 for consideration and report the Specifications for Concrete Culvert Pipe prepared by the Joint Concrete Culvert Pipe Committee and offered to the Society at the annual meeting in 1928.

A new Research Committee on Fatigue of Metals was organized in December, 1928, marking another important step in furthering the Society's purpose of promoting knowledge of materials. Reference in appropriate detail to this third research committee of the Society is made in the annual report of Committee E-9 on Correlation of Research.

The Special Committee on Promotion of General Use of Specifications for Copper Alloys in Ingot Form, mentioned in the annual report a year ago, was organized last fall for the purpose "to study and promote the use of specifications covering copper alloys in ingot form as the basis of price quotations in technical and trade journals, with authority to recommend to the appropriate standing committee of the Society such revisions in the A.S.T.M. specifications affected as its studies may indicate to be desirable." This committee in cooperation with the Non-Ferrous Ingot Metal Institute is now engaged in a comparative study of the requirements of all existing specifications for copper alloys.

Committee C-1 on Cement is reporting to the Society this year the establishment on the fellowship plan at the U. S. Bureau of Standards of a Reference Laboratory for Standard Cement Testing for the purpose of instructing on established methods of making tests and proper methods for maintaining testing equipment, and also calibrating testing equipment submitted by purchasers or manufacturers of such equipment. The staff of the Reference Laboratory will make on request of the directing head of a cement testing laboratory a report upon the adequacy and accuracy of its apparatus to make tests in conformity with standard specifications, and will issue suitable certificates covering such testing apparatus. The Laboratory is being financed half by the United States Government and half by the cement industry through the Portland Cement Association, the latter funds being administered through Committee C-1. The establishment of the Reference Laboratory along the lines reported at this annual meeting by Committee C-1 has met fully with the approval of the Executive Committee.

Organization of New Committee E-10 on Standards:

After a careful study of the standardization activities of the Society, particularly from the administrative viewpoint, and in consultation with the standing committees through Committee E-5, the Executive Committee has authorized the organization of a new committee to be known as Committee E-10 on Standards. The following abstract from a report on this matter by one of the committees of the Executive Committee explains the principal considerations that have led to this decision:

> "Under the By-laws of the Society the general management of its affairs is vested in the Executive Committee, in whose hands therefore rests ultimately the executive direction of Society activities in general. These executive and administrative responsibilities in certain matters have been shared with or under certain restrictions delegated to standing committees of the Society, which in our chart of organization appear under group 'E—Administrative and Advisory.'[1] Thus in the matter of papers and publications, Committee E-6 has been given 'full authority by the Executive Committee in all matters affecting acceptance, rejection, editing and publication of papers, committee reports and discussions.' In questions of broader policy respecting publications of the Society the Executive Committee may refer matters to Committee E-6 for its advice and recommendations or such matters may originate within Committee E-6, who may recommend desirable policies for decision of the Executive Committee. Again, in 1924, the Executive Committee formed Committee E-9 on Correlation of Research and charged it with the broad function of advancing the research activities of the Society along sound lines, correlating the research activities of the committees of the Society and advising with the Executive Committee in all matters of policy relating to that side of our work concerned with 'the promotion of knowledge of materials of engineering.'
>
> "In the other of the two main functions of the Society, namely, "standardization of specifications and tests for materials," the Executive Committee has not delegated any executive or administrative authority nor has it set up is consider broad questions of standardization policy a committee comparable to Committees E-6 and E-9 in their fields. In 1912 the Executive Committee formed Committee E-5 on Standing Committees (consisting of the chairmen

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[1] 1928 A.S.T.M. Year Book, p. 151.

of all the other standing committees) and shared with it the responsibility for the general Regulations Governing Standing Committees, with the understanding that a proposed change in the Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee and that the Executive Committee shall make no changes in the Regulations without first referring the same to Committee E-5. The duties of Committee E-5 were defined as "the formulation of (*a*) Regulations Governing Standing Committees, (*b*) Regulations Governing the Form but not the Substance of Standards, and (*c*) Classification of Standards." These functions are legislative in character and have not at any time carried the thought of executive or administrative functions.

"It appears to your Committee on Inter-Committee Relations from a study of this matter from an administrative and organization point of view that the formation of a Committee on Standards, having functions and authority comparable to those of Committees E-6 and E-9, is desirable in view of the magnitude and extent of our standardization work, of its growing importance to industries of the country and of the importance, and indeed in a way the urgency of new relationships in standardization work that are coming rapidly to the front.

"Accordingly, it is recommended that there be organized a new standing Committee E-10 on Standards to consist of five members of the Society appointed by the Executive Committee with the Secretary-Treasurer acting *ex-officio* as secretary of the committee; the committee to act in an advisory capacity to the Executive Committee in matters concerning the standardization work of the Society and to have in general the following duties and authority, subject to such restrictions as might be imposed from time to time by the Executive Committee:

> "1. To promote the standardization work of the Society and to consider matters of general policy concerning A.S.T.M. standardization activities, including the relationship of such activities with similar activities of other bodies.
>
> "2. To review annually the progress of the Society's standardization work and to consider the desirability of extending that work from time to time into new fields, which might involve an extension of the activities of existing committees or the organization of new committees.
>
> "3. To perform such functions as might be assigned to it in connection with a possible modification of the Society's standardization procedure looking to the earlier promulgation of proposed standards as A.S.T.M. Tentative Standards."

The committee will be constituted along the lines above outlined and its functions will be substantially as recommended. The President has been authorized to name the committee and to discuss with its members the further details of its functions and methods of operation.

The Executive Committee believes that the new committee which is in course of appointment will develop into a most important administrative committee, particularly with respect to the problem of extending the Society's standardization work over the entire field of engineering materials and the relationship of our standardization activities with those of other bodies. An important function will be the review of proposed new standards offered to the Society between annual meetings, as discussed below. It is desired particularly to emphasize that the new committee is not a standards-making committee; it will not write specifications nor methods of test nor definitions. Its relationship towards the standardization work of the Society will be closely analogous to that of Committee E-9 on Correlation of Research towards the research and investigative activities of the Society.

A Modification in the Society's Standardization Procedure:

The consideration of certain steps in the standardization procedure of the Society has been one of the most important matters coming before the Executive Committee during the year. It has been felt that with only one opportunity a year, namely, the annual meeting, for the standing committees to present reports on research or standardization activities and for official action upon recommendations affecting standards and tentative standards, the procedure is somewhat lacking in flexibility, and therefore may not be as well adapted to the needs of modern industrial standardization as it should be for the Society to render the most effective service to its members and to the industries of the country. The subject was assigned for study to a committee of the Executive Committee, from whose report the following paragraphs are abstracted:

> "A study of the Society's standardization procedure indicates that it may be entirely possible to accelerate this procedure without in any wise sacrificing the necessary safeguards that the procedure throws around the establishment of an A.S.T.M. standard. It is, for example, a matter of observation that in a great majority of cases the work of the committees of the Society is so well considered and gives such complete opportunity for all interests to be heard that the action of the annual meeting in voting to accept a specification or method of test as *tentative* is becoming rather a perfunctory matter; and your committee has felt that it would in no wise be a serious modification of the essential principles back of our procedure if suitable means were set up whereby proposed standards, after they have been adopted by the prescribed letter ballot vote of the standing committee, should be reviewed by a suitable 'Committee on Standards,' which after reviewing the report of the standing committee and satisfying itself that there was substantial unanimity of opinion with no important minority against the standard, would have authority immediately to bring about the publication of the proposed standard as an A.S.T.M. tentative standard. Under this plan it would be possible to give a proposed standard tentative status without waiting for an annual meeting, which in effect is an extension of the plan that has already been adopted by the Executive Committee and is being developed by the Secretary-Treasurer, of preprinting proposed standards as soon as they have been balloted upon by the standing committees and making them immediately available to Society members who request them.

"There are several important considerations that in the opinion of your committee justify consideration of such a modification in our procedure. Perhaps the most important is the advisability of adapting our standardization procedure to developments that are taking place in the standardization movement in industry. Your committee is firm in its belief that it is undesirable, in fact dangerous, to sacrifice any important principle of our standardization procedure, as for example the value of deliberative and representative methods of arriving at technical standards, for sake merely of speed. At the same time if there is some time lag that can be 'taken up' in our procedure that will make it more adaptable to the needs of industry and that in particular will encourage industries to look to the Society and its committees to work out standardization problems in our field in the expectation of having standards developed and given at least tentative status within a reasonable time, your committee believes that it will be to the best interests of the Society to modify its procedure to this end.

"Some other considerations are that our standing committees would be encouraged to complete sections of their work as rapidly as possible knowing that proposed standards upon which the committee had reached definite conclusions could be offered at once for consideration as tentative and not have to await the holding of our annual meeting. Under the present procedure there is an undoubted tendency to postpone the work on some matters until the few months preceding the annual meeting since the committees realize that their only present means of bringing out specifications is through a report at our annual meeting in June. It is felt that the proposed procedure would be a healthy stimulus to committees and an incentive once a particular problem is attacked to bring it as quickly as possible to a conclusion; and your committee feels that the development of such an attitude on the part of the committees of the Society will be distinctly helpful in our relations with the standardization movement in general. It is also pointed out that the institution of such a procedure would be an important step in the direction of spreading out the 'publication load' throughout the year, avoiding a continued concentration of this load in the few months preceding the annual meeting—a matter which is one of compelling importance.

"It is accordingly recommended that the Executive Committee adopt as a policy the desirability of expediting the formulation and promulgation of proposed standards without sacrifice of the fundamental principles embodied in our By-laws and Regulations Governing Standing Committees that safeguard the establishment of A.S.T.M. standards."

In acting favorably upon this latter recommendation, the Executive Committee decided to make the following proposals to Committee E-5 on Standing Committees, with whom it shares responsibility for modifications in the Regulations Governing Standing Committees, which embody the standardization procedure:

1. That the committees of the Society be authorized to present reports to the Executive Committee at any time between annual meetings.

2. That proposed new standards or proposed amendments of existing tentative standards contained in such *ad interim* reports, if

completed by the standing committee in full accordance with all the requirements for committee procedure in development of standards, be referred to the proposed new Committee E-10 on Standards, which shall then have the responsibility of reviewing the report and satisfying itself that all requirements of the Regulations have been complied with and that the standing committee has reached a substantial consensus favoring the acceptance of the proposed new standard or amendment of existing tentative standard as A.S.T.M. tentative. If the review is satisfactory to the Committee on Standards it may accept the proposed new standard or proposed amendment of existing tentative standard for publication as A.S.T.M. Tentative Standard. A tentative standard so promulgated between annual meetings is to be formally brought before the succeeding annual meeting, where it will be subject to amendment in the usual way and will normally be continued as tentative for another year.

3. That in the consideration of proposed new standards by Committee E-10, two representatives of the standing committee concerned shall serve as members of Committee E-10 with full privileges of discussion and vote, and that the rights of members making minority reports shall be fully protected.

4. That if these proposals meet with favor in Committee E-5, that committee submit modifications of the Regulations Governing Standing Committees required to make the proposals effective.

Committee E-5, as will be noted in its current report to the Society, considered these proposals, approved them and is reporting the necessary modifications in the Regulations Governing Committees, which have been approved by the Executive Committee. Since these modifications involve an amendment of Article VI of the By-laws on "Procedure Governing the Adoption of Standards," which article forms a part of the Regulations, the Executive Committee recommends that the amendments of Article VI proposed later in this report be adopted by the prescribed letter ballot vote of the Society.

In its annual report Committee E-5 has appropriately discussed the most significant features of this new procedure as it affects committee activities and the promulgation of proposed new standards in the interim between annual meetings. It is only necessary here to emphasize two things:

First, that the procedure in effect offers to standing committees two alternative methods for the promulgation as tentative of proposed new standards and proposed amendments in existing tentative standards, and that in so doing no modification is made either in the prescribed procedure within a standing committee for the preparation and adoption of proposed standards or amendments of standards, nor in the prescribed procedure of the Society in formally adopting A.S.T.M. standards. Thus, while standing committees may give advance notice of their intention to request that tentative standards be advanced to standard or that revisions be made in existing standards, action in such matters can still be taken only by the Society itself in annual meeting.

Second, that Committee E-10 on Standards in reviewing between annual meetings proposed new standards or amendments of existing tentative standards offered by standing committees is in effect performing the functions of a session of the annual meeting with perhaps the added advantage of opportunity for more careful scrutiny of procedure and consideration of the merits of any moot points; it represents in effect the interests of the Society as a body in assuring itself of justification for publication as tentative of a proposed new standard. It is to be remembered that tentative standards are not *standards* of the Society adopted by its formal letter ballot vote, and are published primarily to secure criticism and comment. It is believed that the earlier bringing out of tentative standards where possible will render greater service to all concerned and will develop more and better criticism and discussion of the new standard. The essential purposes in mind in expediting the standardization procedure of the Society are in the opinion of the Executive Committee fully met by furnishing this means for more quickly promulgating *tentative* standards.

Interpretation and Enforcement of Regulations Governing Standing Committees:

While questions of interpretation and enforcement of the provisions of the Regulations Governing Standing Committees have but seldom arisen, there has heretofore been no procedure established for handling such matters. It seems desirable that this authority should be given to Committee E-5 on Standing Committees and the Executive Committee has delegated such authority to that committee, with the understanding that in case of disagreement between Committee E-5 and the standing committee the latter shall have the right of appeal to the Executive Committee. A note to this effect will be included in the introduction to the Regulations Governing Standing Committees.

Recommended Enlargement of Executive Committee:

On several occasions the Nominating Committees of the Society have suggested that consideration be given to increasing the number of Members of Executive Committee—at present eight, four being elected each year for a term of two years—in order that the major fields of activity in the Society may at fairly frequent intervals be represented in the executive direction of Society affairs. In the fifteen years during which the Executive Committee has been constituted in accordance with the present provisions of the By-laws, Society activities have extended into many new fields and on several occasions the Nominating Committees found it difficult to give adequate representation on the Executive Committee to some of the newer and active groups that have come into the Society.

A study of this matter leads the Executive Committee to recommend that the number of Members of Executive Committee be increased from eight to ten, under which plan there would be elected each year to serve for the term of two years five instead of four members. This will give opportunity for making the Executive Committee still more broadly representative and at the same time the enlargement of the total membership from fifteen to seventeen would not make the Committee in any sense unwieldy.

The modification of Article II of the By-laws required to bring this about is made formally in the following section of the report. If these amendments are approved the Executive Committee recommends that they become fully effective by the 1931 annual meeting; that is, the Nominating Committee in 1930 will nominate five Members for a two-year term (so that in 1930–31 there will be nine Members of Executive Committee), and in 1931 will again nominate five Members for a two-year term, which will then bring the number of Members of Executive Committee to ten.

The Executive Committee also recommends that the By-laws be amended to provide that a quorum of the Executive Committee shall be seven instead of five Members. The necessary amendment of Article IV, Section 1, of the By-laws is given below.

Proposed Amendments of the By-laws:

To accomplish the purposes outlined in the preceding sections of this report, the Executive Committee proposes the following amendments of the By-laws:

Article II. Officers and Their Election:

Amend Sections 1, 2 and 4 to read as follows by the addition of the italicized words and the omission of those in brackets:

Section 1. The officers shall be a President, two Vice-Presidents, a Secretary-Treasurer and [eight] *ten* Members of Executive Committee.

Sec. 2. The Executive Committee shall consist of these [twelve] *fourteen* officers and the last three Past-Presidents.

Sec. 4. The President shall hold office for one year. The two Vice-Presidents and the Members of Executive Committee shall hold office for two years. The terms of office of one Vice-President and [four] *five* Members of Executive Committee shall expire in the even years, and those of one Vice-President and [four] *five* Members of Executive Committee in the odd years.

Article IV. Duties of Officers:

Amend the last paragraph of Article IV, Section 1, to read as follows by the addition of the italicized word and the omission of the word in brackets:

[Five] *Seven* members of the Executive Committee shall constitute a quorum.

Article VI. Procedure Governing the Adoption of Standards:

Amend the first sentence of the second paragraph of Article VI, Section 1, to read as follows by the insertion of the italicized words:

(*a*) Proposed new standards, ***except as provided in Paragraph*** (*b*), shall be presented at an annual meeting, at which they may be amended by a two-thirds vote of those voting.

Add the following new paragraph between the present second and third paragraphs of Section 1:

(*b*) Proposed new standards or proposed amendments of existing tentative standards may also be presented between annual meetings, in which case they shall be reviewed by the Committee on Standards, which shall determine whether all requirements relating to the preparation and submission of standards have been complied with and whether the standing committee has reached a substantial consensus in its recommendations to the Society. If such review is satisfactory to the Committee on Standards, it may accept the proposed new standards or proposed amendments of existing tentative standards for publication as tentative standard. During consideration of and action upon the recommendations of a standing committee, two designated representatives of the standing committee shall serve as members of the Committee on Standards, with full privileges of discussion and vote. At the annual meeting following the publication of a tentative standard or amendment under this procedure the standing committee concerned shall report the acceptance of the tentative standard or amendment, which shall be subject to amendment at that annual meeting by a two-thirds vote of those voting. Tentative standards reported at an annual meeting for the first time shall normally be continued as tentative.

Add the designating paragraph letter (*c*) to the present third paragraph of Section 1.

Add the designating paragraph letter (*d*) to the present fourth paragraph of Section 1.

Amend the first sentence of the present fifth paragraph of Section 1 to read as follows by the addition of the italicized words and the omission of those in brackets:

(*e*) The [above requirement] ***requirements in Paragraphs*** (*a*), (*b*), ***and*** (*c*) by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or more years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented.

Add the designating paragraph letter (*f*) to the present sixth paragraph of Section 1.

As required by the By-laws, these amendments were announced to the membership prior to the annual meeting in Circular to Members No. 200 dated May 22, 1929; and the Executive Committee recommends that the amendments be referred to letter ballot of the Society.

Publications:

The regular publications during 1928 were the Proceedings, the Supplement to the triennial Book of A.S.T.M. Standards, the Year Book, and for the first time an Index to A.S.T.M. Standards and Tentative Standards. A comparative statement of the volume of regular publications during the four years is as follows:

	1925, Pages	1926, Pages	1927, Pages	1928, Pages
Proceedings	1416	1895	1706	2088
Book of A.S.T.M. Standards	....	....	1871	....
Supplement to Book of Standards	117	102	....	195
Year Book (Membership List)	352	374	398	309
Index to A.S.T.M. Standards and Tentative Standards	....	....	....	95
	1885	2371	3975	2687

The volume of regular Society publications since 1902 is recorded graphically in Fig. 1. With the exception of 1924, the Proceedings for 1928 are the largest yet published.

In addition to the regular publications the Society published in 1928 the Book of A.S.T.M. Tentative Standards (932 pp.), which is furnished to members on order at special prices. This brings the total number of pages of bound publications issued since the last annual meeting, but not including preprints and reprints, up to 3619.

The publication of the Index to A.S.T.M. Standards and Tentative Standards, which has been made possible largely by the increased income of the Society through company membership dues, has added to the Society publications one that should be of particular value to the members. The number of standards and tentative standards has increased rapidly in the past few years and the issuing of an annual Index to the Standards and Tentative Standards in one volume will greatly facilitate reference to the specifications, methods of test and definitions of the Society, be they standard or tentative. The Index will also be of value to all users of materials interested especially in specifications and tests, and it is planned to distribute copies to selected lists of users in order to bring effectively to their attention the availability of A.S.T.M. specifications in the purchase of materials. Thus this year copies of the Index were sent to the five thousand members of the National Association of Purchasing Agents, of whom over a thousand have requested that their names be placed on the permanent mailing list to receive copies annually.

The Executive Committee has decided to add an advertising section to the annual Index to A.S.T.M. Standards and Tentative Standards, advertising of the following character being contemplated: advertisements by manufacturers and suppliers of engineering materials and products; advertisements by manufacturers and suppliers of testing machines, apparatus and equipment; and professional cards of consulting engineers, metallurgists, chemists, testing engineers and testing laboratories. Advertising of the second and third types has appeared in the A.S.T.M. Bulletin for the past three years, where it has been recognized as a useful service to the members as well as to the advertisers and at the same time has placed the Bulletin on practically a self-sustaining basis. Present policies respecting Bulletin advertising will be continued.

The A.S.T.M. Bulletin was continued in 1928 on the bi-monthly basis, the six Bulletins of the year comprising 58 pages of text matter dealing with appropriate announcements of general Society affairs, committee activities, cooperative relations with other organizations, and other matters of interest to the members. These issues of the Bulletin cost $3626.81, including mailing charges but exclusive of overhead expenses; while the income from advertising was $3919.

Reprints of several committee reports were again published for committee use and for sale, the principal ones in 1928 being the report of Committee A-5 on Corrosion of Iron and Steel, 34 pages (1500 copies); the report of Committee D-2 on Petroleum Products and Lubricants, with all the standards and tentative standards that it has promulgated, 268 pages (2000 copies); a report of the same committee on "Significance of Tests of Petroleum Products," 52 pages (2500 copies); and the report of Committee D-9 on Electrical Insulating Materials, with all the standards and tentative standards that it has promulgated, 155 pages (750 copies). In each case the cost of these copies was underwritten by the respective standing committees and such reprinting will be undertaken for any committee of the Society on this basis.

Finances of the Society:

Report for Fiscal Year 1928.—The annual statement of the finances of the Society follows in the report of the auditors for the fiscal year, January 1, 1928, to December 31, 1928, which includes the balance sheet, statement of receipts and disbursements, statement of miscellaneous funds held for committees, the Dudley Medal and Marburg Lecture Fund, and investments.

As will be seen from the balance sheet, the surplus at the close of the fiscal year was $40,504.70. In addition the life membership fund comprises $2705.20, and there has been invested from 1928 income a sinking fund towards the cost of the 1930 Book of Standards of $6057.80. The A.S.T.M. Research Fund was increased from $3246 to $4626.60 by the investment of approximately one-half of the entrance fees for the year. Two new special funds were created: a Headquarters Fund towards the expenses incident to possible removal of Society headquarters, the amount in this fund at the close of the fiscal year being $2015; and a Publications Fund, from which to meet the cost of special or extraordinary publications that cannot be met from current funds, the amount at the close of the fiscal year being $1007.50. A comparison of the financial condition of the Society at the close of the past five fiscal years is given in detail at the end of the auditor's report.

The report also lists the funds held for the account of committees and joint committees of the Society (totaling $20,333.31), and gives also a statement of the Dudley Medal and Marburg Lecture Fund. Investments of Society and other funds are listed.

At its meeting in January, 1929, when the finances of the fiscal year 1928 were reviewed, it was decided to re-allot a portion of the surplus consisting of certain 1928 income that had been temporarily invested and which appears in the auditors' report under investments of Society funds (general) in the amount of $5037.50. The sum of $2015 has been assigned to the Headquarters Fund, $1007.50 to the Publications Fund, $1511.25 to the A.S.T.M. Research Fund, increasing each of these funds by the respective amounts over the sums reported in the balance sheet as of December 31, 1928, and leaving $503.75 in the general Society funds. To the A.S.T.M. Research Fund there has been also added the sum of $250 contributed by the Local Committee on Arrangements for the group committee meetings held March, 1929, in Chicago. The Research Fund therefore comprises at this time practically $6400, including $250 contributed by Chicago committee at March Group Meeting; the Headquarters Fund totals $4030 and the Publications Fund $2015.

REPORT OF THE AUDITORS FOR THE FISCAL YEAR JANUARY 1, 1928, TO DECEMBER 31, 1928

PHILADELPHIA, January 4, 1929.

AMERICAN SOCIETY FOR TESTING MATERIALS,
MR. C. L. WARWICK, *Secretary-Treasurer*,
Philadelphia, Pa.

Dear Sirs:

We respectfully report that we have made an audit and examination of the books and accounts of your Society for the seven months ended December 31, 1928, having previously made a similar audit and report for the preceding five months ended May 31, 1928, and at both audits found the accounts to be correct and to be in excellent condition.

We submit balance sheet as of December 31, 1928, as also a statement of cash receipts and disbursements for the twelve months then ended.

We have verified the transactions set forth in the budget record for the seven months ended December 31, 1928, as also for the five months ended May 31, 1928, as reported in ours of June 15, 1928, and found the same to be correct.

We have verified by actual inspection and count the securities as scheduled under Investments.

Respectfully submitted,
(Signed) JOHN HEINS AND CO.,
Certified Public Accountants.

BALANCE SHEET AS OF DECEMBER 31, 1928

ASSETS				
Current Funds			$978.56	
Investments			44 752.09	
Accounts Receivable:				
For Publications and Advertising		$3 558.71		
Members, for 1928 Dues		3 221.89		
Members, for Binding		50.50		
			6 831.10	
Furniture and Fixtures			5 327.09	
				$57 888.84
LIABILITIES				
Publications and Advertising paid for in advance		$175.55		
Members Dues paid in advance		494.49		
Members Binding paid in advance		10.00		
Entrance Fees paid in advance		60.00		
			$740.04	
Income, A.S.T.M. Research Fund			230.00	
New International Association for Testing Materials			2.00	
Life Membership Fund	$2 705.20			
A.S.T.M. Research Fund	4 626.60			
Headquarters Fund	2 015.00			
Publications Fund	1 007.50			
Book of Standards Reserve	6 057.80			
		$16 412.10		
Surplus		40 504.70		
			56 916.80	
				$57 888.84

RECEIPTS AND DISBURSEMENTS

Current Funds, January 1, 1928			$1 594.65

RECEIPTS

Current Dues	$7 8052.91		
Past Dues	910.50		
Advance Dues	487.19		
Life Membership Dues	900.00		
Income, Life Membership Fund	100.00		
Entrance Fees	2 575.00		
Total Dues		$83 025.60	
Separate Standards	$2 839.24		
Book of Standards	9 830.85		
Book of Standards—Members for both Parts	537.97		
Book of Tentative Standards	6 285.18		
Proceedings	4 312.82		
Miscellaneous (including special reprints)	6 034.90		
Total Sale of Publications		29 840.96	
Binding (Members)		660.40	
Advertising in Bulletin		4 122.00	
Authors' Reprints		232.19	
Sale of Certificates of Membership		30.00	
Interest on Deposits and Investments		3 137.98	
Accrued Interest and Premium		121.88	
Excess Remittances		129.98	
Investments matured or sold		31 910.00	
Income, A.S.T.M. Research Fund		230.00	
Registration and other fees, Annual Meeting		1 000.50	
Seaview Golf Club (see Disbursements)		167.15	
New Internat. Assn. for Testing Materials, Dues		224.04	
Miscellaneous		17.79	
Total Receipts			154 850.47

DISBURSEMENTS

Publications:			
Year Book	$3 943.90		
Book of Standards	1 084.27		
Book of Standards Supplement	1 812.09		
Book of Tentative Standards	3 706.74		
Proceedings	25 945.87		
Preprints	4 181.46		
Bulletin and Circulars to Members	5 162.57		
Separate Standards	1 637.52		
Index to Standards and Tentative Standards	1 424.32		
Miscellaneous (including special reprints)	3 503.07		
		$52 401.81	
Carried forward		**$52 401.81**	**$156** 445.12

Brought forward		$52 401.81	$156 445.12
Salaries		$35 334.10	
General Office Expenses		6 240.19	
Expenses, Standing Committees		1 698.51	
Expenses, Annual Meeting		2 450.26	
Traveling Expenses—Administrative Committees		1 361.57	
Rent and Insurance, Storage Rooms		321.00	
Rent, Headquarters		2 400.00	
Headquarters Maintenance		254.17	
Furniture and Fixtures		895.50	
Certificates of Membership		18.00	
American Standards Association and Sectional Committees		1 517.13	
Investments:			
1930 Book of Standards Reserve	$6 057.80		
Life Membership Fund	743.40		
A.S.T.M. Research Fund	1 380.60		
Permanent Investments Reinvested	3 159.75		
Current Funds temporarily invested still in hand	8 112.50		
Current Funds temporarily invested matured or sold	29 131.25		
		48 585.30	
U. S. National Committee, International Electrotechnical Commission		$300.00	
Annual Table of Constants and Numerical Data		100.00	
Central Lumber Standards Committee		25.00	
Accrued Interest and Premium		192.91	
Refund of Excess Remittances		129.98	
Seaview Golf Club (see Receipts)		167.15	
New International Association for Testing Materials, Dues		222.04	
Pacific Coast Trip—Secretary-Treasurer		851.94	
Total Disbursements			155 466.56
Balance, Current Funds, December 31, 1928			$978.56
Balance accounted for as follows:			
Cash on hand		$1 478.56	
Liberty Bonds ($4 000), Chesapeake & Ohio R. R. Bonds ($6 000), and Baltimore & Ohio R. R. Bonds ($7 000) carried as Current Funds		17 000.00	
			$18 478.56
Less checks drawn but not paid against cost of Proceedings			17 500.00
			$978.56

MISCELLANEOUS FUNDS

In addition to the regular Society funds the Secretary-Treasurer has on hand the following funds, partly invested as shown:

Committee A-1 on Steel	$35.34	
Committee A-5 on Corrosion of Iron and Steel	9 043.48	
Committee B-3 on Corrosion of Non-Ferrous Metals	7 879.13	
Committee C-1 on Cement	804.09	
Committee C-9 on Concrete and Concrete Aggregates	635.42	
Committee C-10 on Hollow Masonry Building Units	223.59	
Committee D-1 on Preservative Coatings	29.47	
Committee D-14 on Screen Wire Cloth	60.35	
Committee D-18 on Natural Building Stones	230.62	
Joint Committee on Investigation of Phosphorus and Sulfur in Steel	114.82	
A.S.A. Sectional Committee on Cast-Iron Pipe	1 277.00	
Total Committee Funds		$20 333.31

DUDLEY MEDAL AND MARBURG LECTURE FUND

Balance, January 1, 1928:			
Investments		$6 977.50	
Cash on hand		534.41	
			7 511.91
Receipts			
Interest on Deposits and Investments		399.67	
Disbursements			
Cost of 1928 Medal	$90.00		
Honorarium, 1928 Lecturer	200.00		
Engrossing 1928 Lecture Certificate	3.25		
		293.25	
			106.42
Balance December 31, 1928:			
Investments		6 977.50	
Cash on hand		640.83	
			$7 618.33

INVESTMENTS

Society Funds

General:

$17 400	U. S. Liberty Bonds, 4th 4¼'s due 1938	$16 936.58	
2 000	Michigan Central Equipment Bonds, 6's due 1932	2 085.96	
1 000	Baltimore & Ohio R. R. Refunding & General Bonds, 6's due 1995	1 082.00	
3 000	A. T. & T. Co. S. F. Deb. Bonds, 5's due 1960	3 159.75	
5 000	Baltimore & Ohio R. R. 20 year Convertible Bonds, 4½'s due 1933	5 037.50	
			$28 301.79
	Carried forward		$28 301.79

Brought forward		$28 301.79
1930 Book of A.S.T.M. Standards Reserve:		
$6 000 Baltimore & Ohio R. R., 20 year Convertible Bonds, 4½'s due 1933		6 057.80
Life Membership Fund:		
$2 000 Penna. R. R. Bonds, Secured Gold, 5's due 1964	$2 000.00	
700* Consolidated Gas Co. of N. Y. Bonds, 20 year 5½'s due 1945	743.40	
		2 743.40
A.S.T.M. Research Fund:		
$3 000 Baltimore & Ohio R. R. Refunding and General Bonds, 6's due 1995	$3 246.00	
$1 300* Consolidated Gas Co. of N. Y. Bonds, 20 year 5½'s due 1945	1 380.60	
		4 626.60
Headquarters Fund:		
$2 000 Baltimore & Ohio R. R. 20 year Convertible Bonds, 4½'s due 1933		2 015.00
Publications Fund:		
$1 000 Baltimore & Ohio R. R. 20 year Convertible Bonds, 4½'s due 1933		1 007.50
		$44 752.09

DUDLEY MEDAL AND MARBURG LECTURE FUND

$6 500 Baltimore & Ohio R. R. Refunding and General Bonds, 6's due 1995	$6 977.50

COMMITTEE FUNDS

$8 600 U. S. Liberty Bonds, 4th 4¼'s due 1938:			
Committee A-5	$8 259.95		
Committee C-1	509.53		
		$8 769.48	
$2 000 U. S. Treasury Certificates, 3⅞'s due March, 1929	$1 998.75		
$5 000 U. S. Treasury Certificates, 4½'s due June, 1929	5 012.50		
Committee B-3		7 011.25	
			$15 780.73

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* Proportionate share of total investment of $2 000.00.

FINANCIAL CONDITION AT CLOSE OF FISCAL YEARS 1924–1928, INCLUSIVE.

Fiscal Year	Assets				Liabilities			
	Current Funds	Investments	Accounts Receivable	Furniture and Fixtures	Accounts Payable	Reserve for Book of Standards and Index to Proceedings	Special Funds	Surplus
1924.......	$282.06	$19 845.44	$6 909.42	$3 672.90	$4 797.31[a]	$495.94	$1 600.00[c]	$23 816.57
1925.......	5 041.21	24 023.60	3 946.20	3 808.45	1 036.92	4 368.37	1 805.20[c]	29 608.77
1926.......	6 810.58	33 196.26	4 905.90	3 753.09	1 249.01	11 121.16	1 805.20[c]	34 490.46
1927.......	1 594 65	28 403 10	7 461.93	5 023.49	1 919.49	....	5 051.20	35 512.48
1928.......	978.56	44 752.09	6 831.10	5 327.09	972.04	6 057.80[b]	10 354.30	40 504.70

[a] Includes a loan of $4 000.00 from the Girard Trust Co.
[b] Book of Standards Reserve only.
[c] Life Membership Fund only.

It is appropriate in this report, covering as it does the first year of operations under the increased company membership dues, to indicate approximately to what uses the increased income thus derived has been put. Comparison of receipts from membership dues for 1927 and 1928 shows that the increased income realized, after making due allowance for resignations and other losses, is close to $15,000. Of this a total of $5400 was applied to publications, $1000 being added to the Book of Standards reserve and another $1000 to the budget for current Proceedings, $1400 applied to the cost of the new Index of Standards and Tentative Standards and $2000 set aside as a publication fund; the sum of $2800 was applied to the salary of a technical assistant and stenographic assistance required principally for standardization activities; $4000 was set aside as headquarters reserve; $1500 was added to the A.S.T.M. Research Fund; $500 was added to permanent reserve; and the balance, approximately $800, was used for miscellaneous expenses. Expressed in another way, the increased income for the first year's operation under $30 company membership dues has been used one-third for publications, one-fourth for headquarters reserve, one-tenth for the research fund and one-fifth in building up the technical staff to enable it to handle more efficiently the increased standardization work of the Society.

In the foregoing financial statements no account has been taken of the assets of the Society in the form of publications in stock. The inventory on June 1, 1929, may be summarized approximately as follows:

			NUMBER OF COPIES
Proceedings			5 600
Index to Proceeding	Vols. I-XII, incl.		520
	Vols. XIII-XX, incl.		685
	Vols. 21-25, incl.		665
Book of A.S.T.M. Standards	Part I, Metals		520
	Part II, Non-Metals		540
Reprints of 363 Standards		(Approximate)	22 000
Special reprints for general sale		(Approximate)	3 500

1929 Finances.—The Society's activities for the current fiscal year have been based upon a budget that anticipates total receipts, exclusive of investments matured or sold, of $123,700 (approximately the same as for 1928), of which $87,750 are estimated from dues and entrance fees, $26,000 from sales of publications and $9950 from a number of miscellaneous items, including advertising in the Bulletin, registration fee at annual meeting and interest on deposits and investments.

Substantially the same policies have been applied this year as for last year in the budget of disbursements. After making the usual provisions for current expenses, including publications, salaries, general office expenses, expenses standing committees, expenses annual meeting, headquarters maintenance, etc., the sum of $6000 has been applied to the reserve for the 1930 Book of Standards. For the current Proceedings the budget has been increased $1000. There will be added to the A.S.T.M. Research Fund approximately $1600 (one-half of the estimated receipts from entrance fees) and $1000 each is to be added to the Headquarters Fund and the Publications Fund.

Society Headquarters:

The five-year lease upon the quarters now occupied by the Society in the building of the Engineers' Club of Philadelphia expires at the close of this year. The Engineers' Club now having under consideration plans for alterations to its present building or possibly the erection of a new club building on the present site or elsewhere, it was mutually agreed by the Executive Committee and the officers of the Club that the Society should lease its present quarters for an additional two years at a slightly increased rental, equivalent to approximately $1.25 per square foot (a total annual rental of $3000). It is expected that within this period of two years the plans of the Club for its future quarters will have been worked out, in which connection the headquarters requirements of the Society will be duly considered.

While it is the belief of the Executive Committee that it is advantageous to maintain Society headquarters in connection with the

Engineers' Club provided suitable desirable space will be available as the Society's needs increase, studies are being made of other possibilities for the establishment of Society headquarters in the event that it may prove necessary to make some change in the present arrangements.

Edgar Marburg Lecture for 1929:

Upon the recommendation of the Edgar Marburg Lecture Committee consisting of H. F. Moore, chairman, T. R. Lawson and Jerome Strauss, the Executive Committee has invited Dr. Saul Dushman, Assistant Director, Research Laboratory, General Electric Co., to deliver the fourth Edgar Marburg Lecture during the coming annual meeting. Doctor Dushman will speak on "The Nature of Cohesive Forces in Solids."

Award of the Charles B. Dudley Medal for 1929:

Upon the unanimous recommendation of the Committee on Medal Award consisting of W. H. Bassett, chairman, W. A. Slater and H. E. Smith, the Executive Committee has awarded the third Charles B. Dudley Medal to J. J. Kanter, Testing Engineer, Crane Co., and L. W. Spring, Chief Chemist and Metallurgist, Crane Co., for their paper on "Long-Time or Flow Tests of Carbon Steels at Various Temperatures with Particular Reference to Stresses Below the Proportional Limit," presented at the annual meeting of the Society a year ago. The formal award of the medal will be made immediately following the Marburg Lecture.

Relations with Pacific Coast Members:

During the past year the Executive Committee decided to initiate plans that had been under consideration for some time for establishing a closer relationship between the general activities of the Society and the members on the Pacific Coast. As a first step, arrangements were made for the Secretary-Treasurer to visit the members of the Society in the three Coast States of California, Oregon and Washington. Such a visit was made in the fall of 1928 and included the four principal industrial communities: Los Angeles, San Francisco, Portland and Seattle.

The Secretary-Treasurer has presented to the Executive Committee a comprehensive report on the visit outlining the objectives, describing the visit and the contacts made, discussing the relationships with western members, submitting notes on industrial and group contacts, and making recommendations and suggestions for consideration of the Executive Committee. A general account of the Secretary's visit was published in the December, 1928, Bulletin.

The immediate objectives of the visit were:

1. To meet as many of the Society members in the three Coast States as possible in the time available (approximately four weeks) and consistent with certain other objectives;

2. To discuss Society activities with the members and to ascertain their views on ways and means of bringing the western membership into closer touch with Society activities as exemplified in our committee work, with its two-fold purpose of investigation of properties of materials and of standardization of specifications and tests, the presentation of papers and discussions at annual meetings, and in the administration of Society affairs in general;

3. To study, in so far as time permitted, the major industries of the Coast from the point of view of their production, use and testing of engineering materials; to meet the technical leaders of those industries and of other groups and to learn their attitude towards research in materials, standardization of materials and tests and national standardization as a growing economic movement; and also to learn whether in their opinion there were any outstanding materials or tests of such a nature as might for various reasons require local or regional as distinguished from national standards;

4. To give as opportunity afforded, alike to our members and to those not acquainted with our work, a broad conception of the Society and its place in the technical, industrial and economic life of the country; and finally,

5. To lay the groundwork for later extending Society influence and membership on the Coast, should the Executive Committee decide to undertake such activities.

In each of the four localities visited there were held well-attended meetings of members of the Society and others, at which these matters were discussed; and these were supplemented with many personal discussions. The second of the above-named objectives was the one of most immediate importance; and one section of the Secretary's report is devoted entirely to a discussion of these matters, considering both the establishment of a closer relationship between Society activities and the western membership and the means of extending Society influence and membership on the Pacific Coast. The general question of closer relationship between Society activities and the western membership is discussed in the Secretary's report under the heads of standardization activities, research activities, executive and administrative affairs, annual meetings, and possible types of local organizations.

The following recommendations and suggestions were presented to the Executive Committee:

1. That the Executive Committee encourage the appointment upon our standing committees of members on the Coast who are qualified to render service to the committees and are desirous of taking part in such activities of the Society.

2. That the Executive Committee study the feasibility of providing some means by which Pacific Coast members of committees of the Society may function as a group, or means by which groups of members representing producers and consumers may be formed into "divisions" affiliated with and functioning as a part of the standing committees.

3. That our Pacific Coast members be invited to express their interest in the investigative work of the Society and be encouraged to offer their services in cooperating in various phases of that work.

4. That the Executive Committee give consideration to encouraging the election to the Executive Committee upon occasion of a member of the Society located on the Pacific Coast.

5. That two members from the Pacific Coast be appointed as "correspondent" members of Committee E-6 on Papers and Publications, principally for the purpose of stimulating the presentation of technical papers and discussions from Pacific Coast members at annual meetings of the Society.

6. That the Executive Committee give consideration to the possibility of arranging for occasional meetings of Pacific Coast members under official auspices.

7. That the Executive Committee appoint local committees of Society members in the Los Angeles, San Francisco, Portland and Seattle districts for the broad purpose of promoting the usefulness and extending the influence of the Society in the entire Pacific Coast district and of providing at the beginning of this work of expansion a means of contact between the Executive Committee and the Society membership in these several districts.

These recommendations, together with the amplification of them contained in the Secretary's report, have been and still are being considered by the Executive Committee. There is clearly a consensus of opinion among the members of the Society on the Coast that the work of the Society in the development of standard specifications and tests for materials should reflect to a greater degree than at present the views of the engineering and industrial groups on the Coast. The Executive Committee concurs in this view and is encouraging the appointment of qualified Pacific Coast members upon our standing committees for this purpose, in line with the first recommendation. This matter is now being discussed with the officers of some seven or eight standing committees dealing with products of particular interest to Pacific Coast members and several applications for committee membership are pending. Believing that it would greatly facilitate the consideration of both the principles and details involved in working out a closer relationship with members far removed from the center of Society activities, the Executive Committee has appointed local committees of Society members in the Los Angeles, San Francisco and Seattle districts for the general purposes mentioned in the seventh recommendation. These three committees have been formally organized and it is probable that a fourth committee will be formed in the Portland district. The Executive Committee will discuss with these committees and through them with the members on the Coast such matters as the functioning of members or groups of members in connection with standing committee activities, the types of local organizations, if any, best suited to the needs of the Society and its members in that locality and other matters designed to bring the members into closer touch with Society affairs.

It is particularly desired to stimulate the presentation of technical papers and discussions from Pacific Coast members in line with the fifth recommendation and it is planned to appoint two or three members from the Coast as "correspondent" members on the Committee on Papers and Publications for this purpose.

The personnel and other details of the organization of these committees and notes of the progress of their work will appear from time to time in the A.S.T.M. Bulletin.

New International Association for Testing Materials:

The Society's representative on the Permanent Committee of the New International Association for Testing Materials, Past-President W. H. Fulweiler, is now engaged in preliminary arrangements for the participation of the Society in the next Congress of the International Association, which is to be held in Zurich in 1931. The activities of the Association have been divided into the following four sections: A, Metals; B, Non-Metallic Inorganic Materials; C, Organic Materials; D, Questions of General Importance. A number of subjects in each of these four groups that the Permanent Committee suggested should be discussed at the Zurich meeting were submitted to Mr. Fulweiler with the request that there be prepared preliminary reports upon such of these topics as the Society would be interested in seeing included in the program of the next Congress. Mr. Fulweiler extended invitations to a number of members of the Society to act as "reporters" on these subjects, explaining that a review of the preliminary reports received from all the countries represented in the N.I.A.T.M. would very largely determine the character of the next Congress. Eighteen reports covering subjects in each of the four sections have been prepared and have been forwarded to the chairmen of the four sections.

On June 1, 1929, there were 243 members of the Society who had become members of the International Association, 38 being company and 205 being individual members.

International Discussion of Road Materials Definitions:

During the year the Executive Committee received a report from Prévost Hubbard, secretary of Committee D-4 on Road and

Paving Materials, who had represented the Society at a conference in the spring of 1928 with the British Engineering Standards Association for the purpose of discussing definitions of terms relating to bituminous road materials that had been approved by a committee of the International Roads Congress. The report discussed matters that were of direct interest to Committee D-4, Committee D-2 on Petroleum and Lubricants and Committee D-8 on Bituminous Waterproofing and Roofing Materials, and accordingly the report has been referred to the three committees, who have appointed conferees to consider the recommendations made by Mr. Hubbard. It is expected that a report on proposed modifications of A.S.T.M. definitions of certain terms involved in this international discussion will be reported at this annual meeting.

World Engineering Congress in Tokyo:

The Executive Committee has accepted an invitation for the Society formally to participate in the World Engineering Congress to be held in Tokyo this year under the sponsorship of the Japanese Government. The committee in charge of American participation in the Congress requested that the Society sponsor a paper on "Engineering Materials." Such a paper has been prepared by H. F. Moore, Professor of Engineering Materials, University of Illinois and Past-President of the Society, for presentation at the Congress. Official delegates from the Society are being appointed.

American Standards Association:

During the year, as reported currently in the September, 1928, and December, 1928, issues of the Bulletin, a reorganization of the American Engineering Standards Committee was effected by changes in its Constitution that were duly ratified by unanimous approval of the member bodies. The principal features of this reorganization were three-fold: First, the formation of the American Standards Association as a group of national organizations for the purpose of coordinating their standardization activities; second, the placing of the technical work of approving standards in a "Standards Council" to be composed of not more than three representatives of each of the member bodies; and third, the concentration of administrative and financial responsibility for the work of the Association in a Board of Directors composed of twelve industrial executives. The underlying principles of the former A.E.S.C. remain unchanged and the basic functions continue completely in the hands of the representatives of the member bodies. The individual members both of the Board of Directors and the Standards Council, the latter corresponding in its organization and functions very closely to those of the former A.E.S.C. itself, are appointed or nominated by the member bodies, which thus remain the fundamental units in the organization. The Executive Committee has approved the revised Constitution on behalf of the Society and has continued Messrs. Capp, Farmer and Stevenson as the Society's representatives on the Standards Council. Having been one of nine member bodies invited to nominate a member of the Board of Directors, the Executive Committee named in this capacity Mr. Quincy Bent, Vice-President of the Bethlehem Steel Corporation, who has accepted the appointment and will serve as a member of the new Board of Directors.

As explained in the report a year ago, the Rules and Procedure of the Standards Council governing the approval of standards offered for consideration as American Standard and American Tentative Standard were modified in important particulars, making the rules more flexible and fitting better the varied conditions that are met with in the wide range of industrial subjects covered by A.S.A. activities. Of particular interest to the Society is the procedure that permits technical societies and similar bodies having the making and promulgation of standards as a specific function to submit their standards under the so-called "proprietary sponsorship" plan, whereby standards may be offered for approval and subsequently revised within the procedure set up by the sponsor body on the condition that it will be shown that the standard is acceptable to the various groups that are concerned with it. During the year the Society has offered to the Standards Association eleven standard specifications and methods of test for approval as American Standard under this procedure, as follows:

Specifications for Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars (B 4 – 27);
Specifications for Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars (B 5 – 27),
Specifications for Manganese-Bronze Ingots for Sand Castings (B 7 – 27);
Specifications for Sheet High Brass (B 36 – 27);
Specifications for Manganese-Bronze Sand Castings (B 54 – 27);
Method of Test for Organic Impurities in Sands for Concrete (C 40 – 27);
Method of Test for Sieve Analysis of Aggregates for Concrete (C 41–24);
Methods of Routine Analysis of White Pigments (D 34 – 27);
Methods of Testing Woven Textile Fabrics (D 39 – 27),
Methods of Routine Analysis of Dry Red Lead (D 49 – 28);
Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 – 27).

During the year the following standards of the Society were approved either as American Standard or American Tentative Standard as indicated:

As American Standard:

- Specifications for Hard-Drawn Copper Wire (B 1 – 27).
- Specifications for Soft or Annealed Copper Wire (B 3 – 27).
- Specifications for Tinned Soft or Annealed Copper Wire for Rubber Insulation (B 33 – 21).
- Specifications and Tests for Portland Cement (C 9 – 26).
- Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 – 28).
- Method of Test for Water and Sediment in Petroleum Products by Means of Centrifuge (D 96 – 28).
- Method of Test for Steam Emulsion of Lubricating Oils (D 157 – 28).

As American Tentative Standard:

- Method of Test for Determination of Bitumen (D 4 – 27).
- Method of Test for Penetration of Bituminous Materials (D 5 – 25).
- Method of Float Test for Bituminous Materials (D 139 – 27).
- Specifications for Cotton Rubber-Lined Fire Hose for Public and Private Fire Department Use (D 296 – 28 T).

The Society is sponsor or joint sponsor for a number of projects that have been assigned to sectional committees, which are listed in the current Year Book. It is also represented upon a number of sectional committees sponsored by other organizations, which are likewise listed in the Year Book. Reports from the following sectional committees have been received during the year: Insulated Wire and Cables, Petroleum Products and Lubricants, and Methods of Testing Road and Paving Materials. Recommendations in the reports of the two latter committees were responsible for the approval of the six methods of test of petroleum products and road materials above listed as approved by A.S.A. The Sectional Committee on Petroleum Products and Lubricants is also recommending at this annual meeting the approval of two other A.S.T.M. methods of test by the A.S.A., one as American Standard and the other as American Tentative Standard. Reports from the Sectional Committees on Specifications for Zinc Coating of Iron and Steel and on Wrought-Iron and Wrought-Steel Pipe and Tubing, containing recommendations on standard specifications, are on the program of this annual meeting, which also includes reports of substantial progress from the Sectional Committees on Specifications for Cast-Iron Pipe and on Classification of Coal.

The Society has kept in touch with the activities of the Sectional Committee on Code for Pressure Piping and the Sectional Committee on Standardization of Pipe Flanges and Fittings. The development by Committee A-3 on Cast Iron of Specifications for Gray-Iron Castings for Valves, Flanges and Pipe Fittings is a direct contribution to certain activities of the latter sectional committee.

During the year two sectional committees in which the Society is interested were organized under the sponsorship of other bodies, as follows: Sectional Committee on Burnt Brick Masonry, on which D. K. Boyd has been appointed representative on behalf of Committee C-3; and the Sectional Committee on Sheeting, on which W. H. Whitcomb, A. M. Tenney and W. F. Edwards have been appointed representatives on behalf of Committee D-13.

As a result of discussions that have continued during the year in the Society's Committees C-7 on Lime, C-9 on Concrete and Concrete Aggregates and C-11 on Gypsum, it has been decided to establish a project under the procedure of the A.S.A. for the development of Specifications for Plastering and a sectional committee on this subject is in course of formation under the joint sponsorship of the American Institute of Architects and the A.S.T.M.

Substantial progress has been made during the year in arriving at standards for symbols used in engineering. The Sub-Committee, of the Sectional Committee dealing with the subject, on Mechanical Engineering and Testing Materials, on which the Society is represented, has finished the compilation of a list of symbols that is now being circulated for comment and criticism. Progress is being made also in the activities of the Sectional Committee on Graphics, in which the Society is interested. The Society is also participating in the work of the recently organized Sectional Committee on Wire and Sheet Metal Gages.

There have been no developments of consequence in the international standardization situation. The International Federation of National Standardizing Associations (I.S.A.) has been organized along somewhat informal lines by the countries of continental Europe. A decision in the matter of American participation through the A.S.A. in the activities of this International Association has been deferred pending the formal organization of the new Board of Directors of the American Standards Association.

Mechanical Standards Advisory Council:

As an outcome of discussions that have extended over two years or more, there has been formed the Mechanical Standards Advisory Council consisting of organizations duly representative of interests in the mechanical field that are concerned with questions of standardization. The Council will act in an advisory capacity to the mechanical industries and to the American Standards Association on standardization projects applying to the products of the mechanical industries and will serve as a general coordinating medium in the mechanical field.

Our Society has many important contacts with standardization activities in the field of mechanical engineering and has participated in the organization of the Council. Cloyd M. Chapman has been named as the Society's representative on the Council and on its Executive Committee, with the Secretary-Treasurer serving as alternate. The Council was formally organized in December, 1928.

Department of Commerce Activities:

The Society has continued its cooperation and contact with the simplification and standardization activities of the Department of Commerce. While most of the projects of the Division of Simplified Practice do not fall within the scope of the Society's work, there have been several during the year that have been of particular interest. These include S.P.R. No. 79 on Malleable Furnace Refractories, which Committee C-8 on Refractories is this year recommending be approved and appended to the appropriate specification of the Society, and S.P.R. No. 1 on Paving Bricks, revisions in which have been approved by Committee C-3 on Brick and are being recommended for incorporation in the Society's specifications.

Simplified practice recommendations with respect to lumber standards, size and terminology of high volatile bituminous coal have been followed by Committees D-7 on Timber and D-5 on Coal and Coke, respectively.

The Executive Committee has during the year discussed with the Director of the Bureau of Standards the relationship between the standardization activities of the Society and the work of the Commercial Standards Unit of the Bureau. It is desired to avoid duplication or conflict of standardization activities. As a tentative basis of coordination of activities it has been agreed that the Society will be consulted in connection with any projects for standardization in the field of engineering materials that may be proposed to the Commercial Standards Unit. Conferences between officials of the American Standards Association and of the Department of Commerce, in which the Society has participated, have been held for the purpose of agreeing upon the appropriate fields of activity of these two groups. This matter is still pending.

During the year the Society has through appropriate committees been represented in conferences on the establishment of commercial standards for the following projects: Steel and Wrought-Iron Pipe Nipples, Brass Pipe Nipples, Furnace and Fuel Oils, and Regain of Mercerized Cotton Yarn. The Commercial Standards on Steel and

Wrought-Iron Pipe Nipples have been formally referred to the Sectional Committee on Wrought-Iron and Wrought-Steel Pipe and Tubing for consideration. The proposed Commercial Standard on Furnace and Fuel Oils has likewise been referred to Committee D-2 on Petroleum Products and Lubricants and is being considered in connection with the activities of that committee in the development of fuel oil specifications. The Commercial Standard for Billet-Steel Concrete Reinforcement Bars has been withdrawn. The Commercial Standards Unit is interested in the development of standards for foundry coke and is keeping in touch with the work that is being done on this subject in Committee D-5 on Coal and Coke.

The Executive Committee is giving consideration to the policies involved in the acceptance or endorsement by the Society of standards offered to it by other bodies, the question having arisen in connection with the request for approval of the Commercial Standard for Stoddard Solvent, a petroleum product falling within the general scope of Committee D-2. It is felt that acceptance or endorsement under such circumstances is possible only through adoption by the Society in accordance with its regular procedure governing such matters, although some form of qualified approval might be possible through appropriate committee action. The matter is still under consideration.

Translation of A.S.T.M. Specifications:

Translation and publication of A.S.T.M. specifications in foreign languages has been continued during the year by the Bureau of Foreign and Domestic Commerce of the Department of Commerce. One of the newer standards of the Society, for Zinc-Coated (Galvanized) Sheets (A 93 – 27), has been issued in the Spanish-English edition and eight numbers previously published in Spanish have been revised and brought up to date.

The specifications of the Society are frequently translated into foreign languages by societies and associations in other countries. Thus a number of specifications have been translated and published in German by the German Society for Testing Materials and some standards have recently been translated into French by the Belgian Standards Association.

Franklin Memorial and Museum:

The Executive Committee has offered the cooperation of the Society to the Franklin Institute in an advisory capacity in the development of a scientific and industrial museum which the Institute plans to establish in conjunction with the erection in Philadelphia of a suitable Memorial to Benjamin Franklin. The project has reached a point where it seems definitely assured that the Memorial and Museum will go forward as planned and the Institute has indicated that it will appreciate the advice and cooperation of the Society with respect to suitable representation in the museum of the progress and developments in the science and testing of materials. A committee consisting of S. T. Wagner, chairman, C. E. Chase, G. H. Clamer, W. H. Fulweiler and H. F. Moore has been appointed for this purpose.

Use of A.S.T.M. Data in Advertising:

The Executive Committee has adopted the following policy to govern the use of data from publications of the Society in advertising:

> Data or statements quoted from Society reports for advertising purposes must be properly acknowledged and must be clearly identified as such and set apart from any interpretations or comments on them that are made by the advertiser. It is preferable that such data or statements shall be quoted in full. When considered necessary to abstract portions of data or statements, such abstracting must be satisfactory to the responsible committee of the Society and be sufficiently complete that it will not state or imply conclusions other than those stated in the official Society reports.

Miscellaneous Cooperative Work:

A considerable amount of cooperative work in addition to that previously recounted in the report is carried on each year more or less as a matter of routine through representation of the Society upon a number of joint committees and upon committees of other organizations. Cooperative work with such groups as the United States National Committee of the International Electrotechnical Commission and the Boiler Code Committee of the American Society of Mechanical Engineers have proceeded along established lines. The Society has maintained official representation on the Division of Engineering and Industrial Research of the National Research Council, the Society's representatives for the next year being President G. W. Thompson and Vice-President T. D. Lynch. Some cooperative projects that have been active during the year are: Development of Uniform Specifications for Marine Boiler Plate with the American Marine Standards Committee, through Committee A-1 on Steel; the development of Specifications for Concrete Brick with the American Concrete Institute, through Committee C-3 on Brick; the development of Specifications for Trolley Wire for Mine Purposes in cooperation with the American Electric Railway Association, National Electrical Manufacturers Association and the American Mining Congress, through Committee B-1 on Copper Wire; and the development of Specifications for 8000-volt Rubber Gloves in cooperation with the

National Electric Light Association, through Committee D-9 on Electrical Insulating Materials.

The Society's representatives on the Joint Committee on Boiler Feed Water Studies are presenting a report to the Society on the activities of that committee of interest to the Society, particularly the development of methods of sampling and analysis of water. Committees C-8 on Refractories and D-9 on Electrical Insulating Materials are both engaged in studies of heat transmission through the materials with which they are engaged and are maintaining contacts with the activities of the Committee on Heat Transmission of the National Research Council. Cooperative work between the Bureau of Standards, American Wood Preservers' Association and the Society, through Committee D-7 on Timber, in the determination of density and thermal expansion constants of creosote oil has been completed and is being reported this year to the Society. Committee D-1 on Preservative Coatings for Structural Materials is cooperating informally with the American Paint and Varnish Manufacturers Association on uniform specifications for petroleum spirits.

The American Petroleum Institute has adopted as A.P.I. Standards all of the A.S.T.M. standard methods of test for petroleum products developed by Committee D-2, an important further step in the countrywide adoption of these methods.

The Executive Committee has under consideration the appointment of a joint committee with the Society of Automotive Engineers on revision of Specifications for Bessemer Automatic Screw Stock, in which both organizations are immediately interested. It is also planned to cooperate with committees of the Structural Division of the American Society of Civil Engineers in the preparation of an engineering manual on Masonry and Reinforced Concrete, on Steel and on Timber.

Respectfully submitted on behalf of the Executive Committee,

G. W. THOMPSON,
President.

C. L. WARWICK,
Secretary-Treasurer.

REPORT OF COMMITTEE A-1
ON
STEEL

During the past year Committee A-1 has held two meetings, one in Philadelphia, Pa., on January 11, and the second in Chicago, Ill., on March 22. A third meeting will be held prior to the presentation of this report to the Society, at which the report will be reviewed and other matters considered.

The Advisory Committee has held three meetings at which matters concerning the general administrative affairs of the committee were considered.

The present membership of the committee is 168, of which 74 are classed as producers, 70 as consumers, and 24 as general interests.

Recommendations Affecting Standards and Tentative Standards

The recommendations of the committee affecting standards and tentative standards are presented first in summarized form together with an analysis of the letter ballot on each item. They are then referred to, where necessary, under the sub-committee activities, being grouped for convenience in the order of the respective sub-committees directly responsible for them. The recommended revisions are given in detail in the Appendix to this report.

I. Proposed Tentative Standards.—The committee submits for publication as tentative the following two proposed specifications as appended hereto:[1]

Proposed Tentative Specifications for Heat-Treated Carbon-Steel Helical Springs;

Proposed Tentative Specifications for Carbon-Steel Forgings for Locomotives; a complete revision of the Standard Specifications A 20 – 28.

II. Tentative Revisions of Existing Standards.—The committee recommends that the revisions in the following standards, which are given in full in the Appendix to this report, be submitted to letter ballot of the Society. These revisions are divided into two groups, as follows:

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[1] See pp. 566 and 555, respectively.—Ed.

Group A.—Revisions recommended for publication as tentative for one year before referring them to letter ballot of the Society for adoption as standard:

Standard Specifications for Open-Hearth Carbon Steel Rails (A 1 - 27);
Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18 - 28);
Standard Specifications for Welded and Seamless Steel Pipe (A 53 - 27);
Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 - 27).

Group B.—Revisions which the committee recommends be referred to letter ballot of the Society immediately by the necessary nine-tenths vote of the annual meeting, for immediate adoption as standard:

Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings (A 17 - 21);
Standard Specifications for Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57 - 24)..

III. Proposed Revisions of Tentative Standards.—The committee recommends that the proposed revisions of the Tentative Specifications for Marine Steel Boiler Plates (A 114 - 28 T), as given in detail in the Appendix, be approved and that the specifications as revised be continued as tentative.

IV. Tentative Standards Advanced to Standard.—The committee recommends that the following tentative specifications with revision as indicated as given in the Appendix to this report be advanced to standard:

Tentative Specifications for Carbon-Steel Castings for Valves, Flanges, and Fittings for High-Temperature Service (A 95 - 28 T), as revised;
Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 - 28 T), as revised;
Tentative Specifications for Structural Steel for Locomotives and Cars (A 113 - 28 T), without revision.

V. Advancement to Standard of Tentative Revisions of Existing Standards.—The committee recommends that the tentative revisions submitted in 1928[1] in the following four standard specifications be adopted as standard:

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, pp. 1113, 1114 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 845, 846.

Standard Specifications for Structural Steel for Bridges (A 7 – 24);
Standard Specifications for Structural Nickel Steel (A 8 – 24);
Standard Specifications for Structural Steel for Buildings (A 9 – 24);
Standard Specifications for Structural Silicon Steel (A 94 – 27).

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARDS			
Proposed Specifications for Heat-Treated Carbon-Steel Helical Springs	75	0	38
Proposed Specifications for Carbon-Steel Forgings for Locomotives	69	1	43
II. PROPOSED REVISIONS OF STANDARDS			
Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets, and Slabs for Forgings (A 17 – 21), immediate adoption	79	1	33
Standard Specifications for Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57 – 24), immediate adoption	65	1	47
Standard Specifications for Open-Hearth Carbon-Steel Rails (A 1 – 27)	62	0	51
Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18 – 28)	79	0	34
Standard Specifications for Welded and Seamless Steel Pipe (A 53 – 27)	71	0	42
Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 – 27)	69	1	43
III. PROPOSED REVISIONS OF TENTATIVE STANDARD			
Tentative Specifications for Marine Boiler Steel Plates (A 114 - 28 T)	66	0	47
IV. ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
Tentative Specifications for Carbon-Steel Castings for Valves, Flanges, and Fittings for High-Temperature Service (A 95 – 28 T), as revised	63	3	47
Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 – 28 T), as revised	62	0	51
Tentative Specifications for Structural Steel for Locomotives and Cars (A 113 – 28 T)	71	0	42
V. ADVANCEMENT TO STANDARD OF TENTATIVE REVISIONS OF STANDARDS			
Standard Specifications for Structural Steel for Bridges (A 7 – 24)	74	0	39
Standard Specifications for Structural Nickel Steel (A 8 – 24)	70	1	42
Standard Specifications for Structural Steel for Buildings (A 9 – 24)	71	0	42
Standard Specifications for Structural Silicon Steel (A 94 – 27)	68	1	44
VI. WITHDRAWAL OF STANDARD			
Standard Specifications for Carbon-Steel Forgings for Locomotives (A 20 – 28)	69	2	42

VI. Withdrawal of Standard.—The committee recommends that the Standard Specifications for Carbon-Steel Forgings for Locomotives (A 20 – 28)[1] be withdrawn since a complete revision has been offered as a new tentative specification.

VII. Tentative Standards Continued as Tentative.—The committee recommends that the following tentative specifications be continued as tentative for another year without revision:

Tentative Specifications for Cold-Rolled Strip Steel (A 109 – 27 T);
Tentative Specifications for Soft Steel Track Spikes (A 65 – 26 T);
Tentative Specifications for Steel Tie Plates (A 67 – 26 T).

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 17.

The above recommendations have been submitted to letter ballot of the committee, which consists of 168 members; 113 members returned their ballots. The analysis of the vote of the committee is given in the accompanying table.

ACTIVITIES OF SUB-COMMITTEES

In the following, the committee presents the foregoing recommendations in detail where necessary, as well as other features of its work, grouped for convenience in the order of the respective sub-committees responsible for them.

Sub-Committee I on Steel Rails and Accessories (E. F. Kenney, chairman).—In addition to clarifying, broadening and correcting existing specifications, Sub-Committee I has taken steps towards the creation of a joint committee with the A.R.E.A. for the drafting of a new specification for a product known in the trade as intermediate manganese rails.

Sub-Committee II on Structural Steel for Bridges, Buildings and Rolling Stock (A. W. Carpenter, chairman).—This sub-committee has given further consideration to the subject of increased tensile requirements for the structural steel grade referred to in the report for 1928 and to the restriction of use of bessemer steel on this grade. It has obtained as a basis for consideration the reactions of organizations interested in all phases of the subject.

Sub-Committee III on Structural Steel for Ships (R. C. Davis, chairman).—Sub-Committee III is recommending a revision, as given in the Appendix to this report, in the marking clause of the Tentative Specifications for Marine Boiler Steel Plates (A 114 – 28 T). The revised wording was adopted at a joint conference of the American Marine Standards Committee, the Steamboat Inspection Service and representatives of Committee A-1 in order to harmonize the marking requirements for this material for the various interests concerned.

Sub-Committee IV on Spring Steel and Steel Springs (H. W. Faus, chairman).—With the cooperation of members of the Railway Spring Manufacturers' Technical Committee and the Sub-Committee on Springs of the American Railway Association, Sub-Committee IV has developed Specifications for Heat-Treated Carbon-Steel Helical Springs now being recommended as appended hereto[1] for publication as tentative. These specifications were developed as a result of the demand from large consumers' organizations for a working basis in the purchase of this product.

Sub-Committee V on Steel Reinforcement Bars (H. H. Morgan, chairman).—In connection with the subject of steel reinforcement bars the Joint Committee, of Committee A-1 on Steel and Committee C-2 on Reinforced Concrete, on Tests for Reinforcement Bars has laid out a program of investigations in which Sub-Committee V through individual membership on the joint committee will consider subjects regarding methods of test relating to the sub-committee's program.

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[1] See p. 566.—ED.

Sub-Committee VI on Steel Forgings and Billets (H. P. Tiemann, chairman).—This sub-committee has brought to a conclusion the results of an extensive investigation on the necessary reduction from ingot to bloom, resulting in the submission of a revision for immediate adoption, as indicated in the Appendix to this report, of the Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings (A 17 – 21). The pertinent details of this investigation will be presented by Mr. L. H. Fry, a member of the sub-committee, in a paper entitled "Reduction from Steel Ingot to Forging," presented at this annual meeting of the Society.[1]

This sub-committee is recommending a tentative revision, as given in the Appendix to this report, of the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18 – 28), consisting of an increase in the manganese content range in Section 7 (*a*), in order to secure better tensile properties.

This sub-committee is recommending a complete revision of the Standard Specifications for Carbon-Steel Forgings for Locomotives (A 20 – 28) in the form of new tentative specifications, appended hereto.[2] The proposed specifications include, in addition to untreated and annealed forgings, requirements for a new class of product, namely, normalized and tempered carbon-steel forgings since forgings of this character are now in extensive use. Modifications have also been made in the yield point, elongation and reduction of area requirements in the annealed class of forging. The development of the new specifications and extensive investigations were carried on under the chairmanship of Mr. Barr, and culminated in the final recommended specifications appended hereto.[2] These revisions include another important feature, namely, that the speed of the testing machine shall be between $\frac{1}{16}$ and $\frac{1}{8}$ in. per minute in determining the yield point. This was based on a number of comparative tests conducted by the Standard Steel Works, the Pennsylvania Railroad and the Westinghouse Electric and Manufacturing Co., which were supplemented to a certain extent by individual tests made by other companies. Mr. T. D. Lynch, as chairman of Sub-Committee XIII on Methods of Testing, is preparing a tabulation of the results to be available for future use.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. 170 (1929).

[2] See p. 555.—ED.

Sub-Committee VII on Rolled Steel Wheels and Steel Tires (R. W. Steigerwalt, chairman).—This sub-committee is recommending for immediate adoption a revision, given in the Appendix to this report, of the Standard Specifications for Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57 – 24), in order to bring these specifications into agreement with the specifications of the American Railway Association.

Sub-Committee IX on Steel Tubing and Pipe (H. H. Morgan, chairman).—A special Committee on Alloy-Steel Tubing reports that practice in this industry has not sufficiently developed to make it practical at present to prepare specifications for this material. The committee is being continued with instructions to collect data and report.

A special committee to develop ways and means of developing specifications for all classes of pipe and tubings, such as fusion and resistance welding, hammer welded and all classes of fabricated pipe, has been formed.

The sub-committee is recommending revisions for publication as tentative, as given in the Appendix to this report, of the Standard Specifications for Welded and Seamless Steel Pipe (A 53 – 27). As a result of a critical review of specifications A 53 a number of changes of an editorial nature will also be made when the specifications are next printed in the Book of Standards.

This sub-committee is joining with Sub-Committee I of Committee A-2 in recommending revisions, as given in the Appendix to this report, of the Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83-27).

Sub-Committee XIX on Sheet Steel and Steel Sheets (J. M. Darke, chairman).—This sub-committee, through a special committee, is investigating and will draw up a new specification covering steel sheets for freight cars.

Approval of the advancement to standard of the Tentative Specifications for Cold Rolled Strip Steel (A 109 – 27 T) has been withheld until final tests are obtained on a new type of test specimen now being investigated.

Sub-Committee XXI on Steel for Welding (F. N. Speller, chairman).—The sub-committee is now better organized to consider specifications for base metal for fusion welding. The committee will appreciate receiving information on experiences with welding various qualities of steel as well as the results of any investigations. The American Welding Society is attempting to develop a satisfactory test for welds. The sub-committee has agreed upon modifications of the Standard Specifications for Steel Plates of Structural Quality for

Forge Welding (A 78 – 27), and for Steel Plates of Flange Quality for Forge Welding (A 89 – 27), to permit more than 0.05 per cent of silicon in steel for forge welding when specified. These modifications will be recommended to Committee A-1 for action during the coming year.

Sub-Committee XXII on Pipe Flanges and Fittings (L. W. Spring, chairman).—During the past two years this sub-committee has carefully considered the requirements in the present Tentative Specifications for Carbon-Steel Castings for Valves, Flanges, and Fittings for High-Temperature Service (A 95 – 28 T) relating to process of manufacture and requirements for chemical composition. In 1927 the committee recommended the elimination of the crucible and converter processes for the manufacture of this product and the fixing of rejection limits for chemical composition, but withdrew the recommendations for further study. The committee is now recommending modifications in these sections of the specifications as given in the Appendix to this report and asking that the specifications, as revised, be advanced to standard. As to process, it is now proposed that the specifications shall provide that "steel shall be made by the electric furnace, open-hearth or other process approved by the purchaser"; and as to chemical composition, the requirements proposed are rejection limits. These recommended revisions represent agreement reached between the producers and users of castings for this special service.

The sub-committee further is recommending the addition to the present Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 – 28 T) of a table of dimensions and weights of lap-welded and seamless steel pipe for high-temperature service which has been developed by the Sectional Committee on Standardization of Dimensions and Material of Wrought Iron and Wrought Steel Pipe and Tubing[1] under the procedure of the American Standards Association for approval as American Tentative Standard. (This table is to take the place of a similar table withdrawn from the specifications last year on the recommendation of the committee.[2]) The Society, which jointly with the American Society of Mechanical Engineers is sponsor for this sectional committee, has been closely in touch with the development of this table which is being offered by the sectional committee for the immediate relief of industry and will be subject to change as the work of the sectional committee develops in the future.

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[1] See Report of Sectional Committee, p. 111.

[2] See Report of Committee A-1 on Steel, *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 92 (1928).

This report has been referred to letter ballot of the committee, which consists of 162 members; 113 have returned their ballots, of whom 112 have voted affirmatively, and 1 negatively.

Respectfully submitted on behalf of the committee,

J. B. YOUNG,
Chairman.

V. H. LAWRENCE,
Secretary.

EDITORIAL NOTE

The proposed Tentative Specifications for Heat-Treated Carbon-Steel Helical Springs were accepted for publication as tentative as were also the proposed Specifications for Carbon-Steel Forgings for Locomotives to supersede the present standard specifications. The tentative specifications appear on pages 566 and 555, respectively. The withdrawal of the Standard Specifications for Carbon-Steel Forgings for Locomotives was accordingly approved.

The proposed revisions of the Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets, and Slabs for Forgings; and for Wrought Solid Carbon-Steel Wheels for Steam Railway Service were approved at the annual meeting by a nine-tenths vote and were subsequently adopted by letter ballot of the Society on September 3, 1929. The standard specifications in their revised form appear in the 1929 Supplement to the Book of A.S.T.M. Standards, pages 40 and 45, respectively.

The proposed tentative revisions of the Standard Specifications for Open-Hearth Carbon-Steel Rails; for Carbon-Steel and Alloy-Steel Forgings; for Welded and Seamless Steel Pipe; and for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes were accepted for publication as tentative and appear on pages 853, 854, 855.

The proposed revision of the Tentative Specifications for Marine Boiler Steel Plates was accepted. The tentative specifications in their revised form appear on page 561.

The Tentative Specifications for Carbon-Steel Castings for Valves, Flanges, and Fittings for High-Temperature Service; for Lap-Welded and Seamless Steel Pipe for High-Temperature Service; and for Structural Steel for Locomotives and Cars were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 53, 58 and 33, respectively.

The tentative revisions of the Standard Specifications for Structural Steel for Bridges; for Structural Nickel Steel; for Structural Steel for Buildings; and for Structural Silicon Steel were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929. The standard specifications in their revised form appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 9, 16, 27 and 22, respectively.

APPENDIX

PROPOSED REVISIONS IN STANDARDS AND TENTATIVE STANDARDS FOR STEEL

In this appendix are given proposed revisions in certain standard and tentative specifications. In connection with each title is given the reference to the publication in which the specifications appear in their present form.

PROPOSED REVISIONS IN STANDARDS

A. Recommended for Immediate Adoption as Standard

Standard Specifications for Carbon-Steel and Alloy-Steel Blooms, Billets and Slabs for Forgings (A 17 – 21)[1]:

Section 6.—Change to read as follows by the addition of the italicized word and the omission of the word in brackets:

> 6. Unless otherwise specified, the billets shall be made from ingots of at least [four] ***three*** times the cross-sectional area of the billet.

Standard Specifications for Wrought Solid Carbon-Steel Wheels for Steam Railway Service (A 57 – 24)[2]:

Section 7. (*q*) Change to read as follows by the addition of the italicized words and the omission of the words in brackets:

> (*q*) ***Diameter of Hub.***—The diameter of ***the*** hub may vary, but unless otherwise specified the thickness of ***the*** wall of the finished bored hub shall not be less than 1¼ in. at any point [for bores 7 in. or under in diameter, nor less than 1½ in. for bores over 7 in. in diameter.] The thickness of the hub wall in any wheel shall not vary more than ¼ in. at any two points equi-distant from the face of the hub.

Figure 2.—In view (*a*) Wheel Circumference Gage, omit the note reading as follows:

> NOTE: Place tape about circumference of wheel, having the brackets in contact with flange. The normal circumference for wheels of each of the different diameters is indicated by the space marked "3." Wheels should be rejected, if the scribed lines on the head piece fall to the left of the space marked "C" or to the right of the space marked "½."
>
> The continuous markings on the upper side of the tape may be used for mating worn wheels.

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 174.

[2] *Ibid.*, p. 219.

B. Recommended for Publication as Tentative

Standard Specifications for Open-Hearth Carbon-Steel Rails (A 1 – 27):[1]

Section 23 (b).—Change from its present form: namely,

> (*b*) No. 2 rails to the extent of 8 per cent of the whole order will be accepted.

to read as follows:

> (*b*) No. 2 rails will be accepted to the extent of 8 per cent of the whole order of 39-ft. standard length rails and 5 per cent of the whole order of 33-ft. standard length rails.

Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18 – 28):[2]

Section 7. (a).—In the table change the manganese content of Class A steel from "0.30 – 0.55" to read "0.30 – 0.60."

Standard Specifications for Welded and Seamless Steel Pipe (A 53 – 27):[3]

Section 3. (b).—Change the first sentence from its present form: namely,

> (*b*) Analyses may be made by the purchaser from each lot of 500 lengths or less of finished pipe.

to read as follows:

> (*b*) Analyses of two pipes in each lot of 500 lengths or less may be made by the purchaser.

Section 4. (a).—In the table of requirements add a footnote reference to the elongation value of 18 per cent for welded bessemer pipe, the footnote to read as follows:

> [a] Gage distances for measuring elongation on welded bessemer pipe of nominal sizes ¾-in. and smaller shall be as follows:

NOMINAL SIZE	GAGE LENGTH
¾ and ½ in.	6 in.
⅜ and ¼ in.	4 in.
⅛ in.	2 in.

Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 – 27):[4]

Section 16. (a).—Change from its present form: namely,

> 16. (*a*) Finished tubes 4 in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over 4 in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter.

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 17.

[2] 1928 Supplement to Book of A.S.T.M. Standards, p. 9.

[3] 1927 Book of A.S.T.M. Standards, Part I, p. 249.

[4] *Ibid.*, p. 242.

to read as follows:

16. (*a*) The outside diameter of finished tubes shall not vary more than $\frac{1}{64}$ in. over the size ordered. For finished tubes up to and including 4 in. in outside diameter, the outside diameter shall not vary more than $\frac{1}{32}$ in. under the size ordered, and for tubes over 4 in. in outside diameter, the outside diameter shall not vary more than $\frac{3}{64}$ in. under the size ordered.

Table II.—Change the table from its present form by the addition of weight requirements for four additional thicknesses, lighter than No. 14 gage and additional weight requirements for sizes $\frac{5}{8}$ to $\frac{7}{8}$ in. inclusive of tubes of thicknesses No. 14 gage and heavier, as indicated in italics in the accompanying Table I:

TABLE I.—STANDARD WEIGHTS OF SMALL SUPERHEATER TUBES.

SEAMLESS ONLY

THICKNESS		WEIGHT, LB. PER FT. OF LENGTH OUTSIDE DIAMETER, IN.				
B.W.G.	IN.	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{3}{16}$	$\frac{7}{8}$
18	*0.049*	*0.301*	*0.334*	*0.367*	.....	.....
17	*0.058*	*0.351*	*0.390*	*0.429*	.....	.....
16	*0.065*	*0.389*	*0.432*	*0.476*	.....	.....
15	*0.072*	*0.425*	*0.473*	*0.521*	.....	.....
14	0.083	0.480	0.535	*0.591*	*0.647*	*0.702*
13	0.095	0.537	0.601	0.664	0.727	*0.791*
12	0.109	*0.600*	*0.673*	0.746	0.818	0.891
11	0.120	*0.647*	*0.717*	*0.807*	0.887	0.967
10	0.134	*0.702*	*0.792*	*0.881*	*0.971*	1.060
9	0.148	.....	.....	....		*1.149*

PROPOSED REVISIONS OF TENTATIVE STANDARDS

Tentative Specifications for Carbon Steel Castings for Valves, Flanges and Fittings for High Temperature Service (A 95 - 28 T):[1]

Section 2.—Change from its present form: namely,

2. The steel shall be made by one or more of the following processes: open-hearth, electric-furnace, converter or crucible.

to read as follows:

2. The steel shall be made by the electric-furnace, open-hearth or other process approved by the purchaser.

Section 4.—Change Paragraph (*a*) to read as follows by the addition of the italicized word and figures and the omission of those in brackets:

4. [(*a*)] The [castings] *steel* shall conform to the following requirements as to chemical composition, [except that the following limitations for carbon,

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 724 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 54.

TABLE II.—DIMENSIONS AND WEIGHTS OF LAP-WELDED AND SEAMLESS STEEL PIPE[a] FOR HIGH-TEMPERATURE SERVICE.[b]

250, 400, 600, 900, AND 1350 LB. PER SQ. IN., WORKING STEAM PRESSURE RATINGS

Working Steam Pressure Rating[c].		250 lb.		400 lb.		400 lb.		600 lb.		900 lb.		1350 lb.	
Hydrostatic Test[c]		750 lb.		1000 lb.		1000 lb.		1500 lb.		2000 lb.		3000 lb.	
Nominal Pipe Size, in.	Outside Diameter, in.	Wall Thickness, in.[d]	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness, in.[d]	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness, in.[d]	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness, in.[d]	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness, in.[d]	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness, in.[d]	Weight per Linear Foot, Plain Ends, lb.
		SEAMLESS LOW OR MEDIUM CARBON PIPE											
½	0.840	0.109	0.850	....	....	0.109	0.850	0 147	1.087	0.147	1.087	0.147	1.087
¾	1.050	0.113	1.130	....	....	0.113	1.130	0.154	1.473	0.154	1.473	0.1875	1.727
1	1.315	0.133	1.678	....	....	0.133	1.678	0.179	2.171	0.179	2.171	0.21875	2.561
1¼	1.660	0.140	2.272	....	....	0.140	2.272	0.191	2.996	0.191	2.996	0.250	3.764
1½	1.900	0.145	2.717	....	....	0.145	2.717	0.200	3.631	0.200	3.631	0.28125	4.862
		LAP-WELDED OPEN-HEARTH				SEAMLESS LOW OR MEDIUM CARBON PIPE							
2	2.375	0.154	3.652	0.218	5.022	0.167	3.938	0.1875	4.380	0.250	5.673	0.3125	6.883
2½	2.875	0.203	5.793	0.276	7.661	0.203	5.793	0.217	6.160	0.276	7.661	0.375	10.01
3	3.500	0.216	7.575	0.300	10.25	0.216	7.575	0.241	8.388	0.3125	10.64	0.40625	13.42
3½	4.000	0.226	9.109	0.318	12.51	0.226	9.109	0.28125	11 17	0.34375	13.42	0.46875	17.68
4	4.500	0.237	10.79	0.337	14.98	0.237	10.79	0.28125	12.67	0.375	16.52	0.500	21.36
5	5 563	0.258	14.62	0.375	20.78	0.258	14.62	0.352	19.59	0.4375	23.95	0.625	32.96
6	6.625	0.280	18.97	0.432	28 57	0.288	19.49	0.385	25.66	0.500	32.71	0.6875	43.60
8	8.625	0.322	28.55	0.500	43.39	0.34375	30.40	0.46875	40.83	0.625	53.40	0.875	72.42
10	10.75	0.365	40.48	0.500	54.74	0.395	43.68	0.53125	57.98	0.750	80.10	1.0625	109.9
12	12.75	0.375	49.56	0.500	65.42	0.500	65.42	0.625	80.94	0.875	111.0	1.21875	150.1
14	14.0	0.40625	58.98	0.625	89.28	0.500	72.09	0.65625	93.52	0.9375	130.8	1.34375	181.6
16	16 0	0.46875	77.75	0.6875	112.4	0.53125	87.77	0.750	122.2	1.03125	164.9	1.500	232.3
18	18.0	0.500	93.45	0.750	138.2	0.59375	110.4	0.8125	149.1	1.15625	208.0	1.6875	294.0
20	20.0	0.5625	116.8	0.875	178.7	0.625	129.3	0.90625	184.8	1.28125	256.1	1.84375	357.5
24	24.0	0.625	156.0	0.9375	230.9	0.750	186.2	1.03125	253.0	1.500	360.5	2.1875	509.6

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[a] While the thicknesses given in this table are theoretically ample to care for both bursting pressure and material removed in threading, it is recommended that where pipe is threaded, a weight at least equal to the 900-lb. class be used to furnish added mechanical strength.

[b] This contemplates temperatures from 450 to 750° F. (230 to 400° C.), or at the discretion of the designing engineer, higher temperatures with appropriate pressures may be used.

[c] All pressures in pound per square inch gage.

[d] Wall thicknesses calculated from the modified Barlow Formula given in Paragraph P-23 of the 1927 Edition of the A.S.M.E. Boiler Construction Code (as revised), increased to provide 12.5 per cent under thickness mill tolerance, then chosen as the next heavier commercial wall thickness.

manganese and silicon are intended to show desired composition and are not to be used for rejection]:

Carbon	0.15—[0.40] *0.45*	per cent
Manganese	not under 0.50	"
Silicon	not under 0.20	"
Phosphorus	not over 0.05	"
Sulfur	not over [0.05] *0.06*	"

Omit Paragraph (*b*) which reads as follows:

(*b*) Manufacturers submitting proposals to furnish material under these specifications shall specify, with their proposals, the limits of carbon, manganese and silicon which they will accept as a basis for rejection.

Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 – 28 T):[1]

Add the accompanying Table II showing dimensions and weights of pipe for high-temperature service.

Tentative Specifications for Marine Boiler Steel Plates (A 114 – 28 T):[2]

Section 13.—Change the marking clause from its present form: namely,

13. (*a*) The name or brand of the manufacturer, the manufacturer's test identification number, Marine "A" or "B," and lowest tensile strength specified shall be legibly stamped on each finished plate in two places about 18 in. from the edges and on each butt strap near the center line about 18 in. from one end. The manufacturer's test identification number shall be legibly stamped on each test specimen.

(*b*) When required, the monogram stamp of the classification societies and the Department of Commerce shall be placed on each plate adjacent to the stamping specified in Paragraph (*a*).

to read as follows:

13. (*a*) The name of the manufacturer, the place where manufactured, Marine A or B, the manufacturer's test identification number, and the tensile strength as specified in Paragraphs (*b*) and (*c*) shall be legibly stamped in two places on each finished plate not less than 12 in. from the edges. Each butt strap shall be stamped near the middle of the plate. The manufacturer's identification number shall be legibly stamped on each test specimen.

(*b*) Plates not over ½ in. in thickness to be used in externally fired boilers for steamers navigated under the provisions of Title L 11, U. S. Revised Statutes, shall be stamped with the least tensile strength, expressed in thousands, as determined by the tests.

(*c*) Plates other than those described in Paragraph (*b*) shall be stamped with the minimum tensile strength specified.

(*d*) The manufacturer shall furnish facilities to the representative of the United States Steamboat Inspection Service and, when required, to the representative of the ship classification society, to place their official monogam stamp adjacent to the stamping specified in Paragraph (*a*).

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 733 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 63.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 719 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 49.

REPORT OF RESEARCH COMMITTEE
ON
YIELD POINT OF STRUCTURAL STEEL

INTRODUCTION

Last year the committee reported results from two series of tests made to ascertain the effect of speed of loading and method of detecting on the yield point of structural steel.[1] In one of these series of tests, No. 271, the specimens were cut from various parts of certain structural steel shapes and provide considerable additional data on the range in quality of such material.

During the past year the committee has had effective cooperation in making two series of tension tests, No. 281 and No. 282.

In Series No. 281, two hundred fifty-two tests were made to supplement available information on range in yield point of specimens cut from various parts of structural steel shapes, to determine the ratio of yield point to ultimate strength, and to determine the proper location from which to cut specimens from such shapes. The complete data for these tests were not available in time to permit proper study of them prior to this annual meeting. Superficial examination of these data indicates that the report on this series will be both an interesting and valuable contribution to the subject. The more important data from tests of Series No. 282 are summarized herein.

SUMMARY OF TESTS OF SERIES NO. 282

Tests of Series No. 282 were made for the committee by H. F. Moore in the Materials Testing Laboratory of the University of Illinois. The material for the tests was donated by the Inland Steel Co.

Purpose.—The purpose of these tests was to compare the effects of speed of loading on the tensile yield point of structural steel tested in screw-gear-driven machines with similar data obtained from tests made in an Amsler hydraulic testing machine.

Material.—Ten cylindrical specimens each 18 in. in length were cut from each of five $\frac{3}{4}$-in. round structural steel bars lettered A, B, C, D, E, of heat No. 23033. The specimens were given the bar letter and were numbered consecutively from 1 to 10, beginning at one end of the bar. Specimens were tested in condition as-received from the rolls. All even numbered specimens were tested in an Amsler machine. All specimens marked 1 and 5 were tested in an Olsen machine, and the remaining odd numbered specimens were tested in a Riehlé machine.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 105 (1928).

Testing.—Each machine had a capacity of 100,000 lb., but for these tests, the Amsler machine was equipped with a pendulum manometer weighing device of only 50,000 lb. capacity.

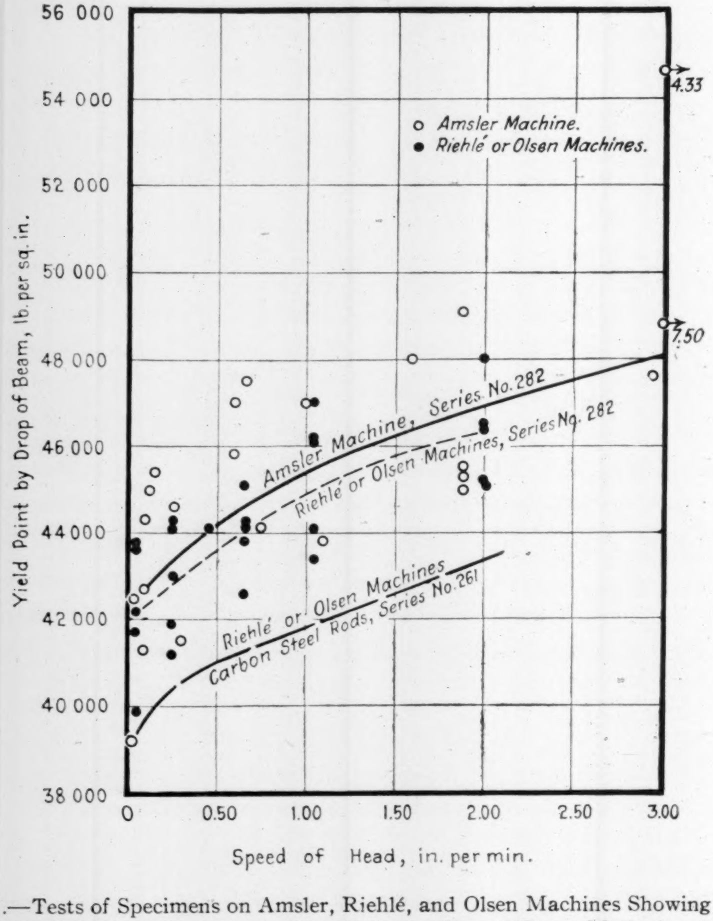

FIG. 1.—Tests of Specimens on Amsler, Riehlé, and Olsen Machines Showing Relationship Between Variation in Yield Point by Drop of Beam Method and Speed of Machines for Tests of Series No. 282.

The three machines were calibrated by the companion bar method using the ultimate strengths of the specimens tested as a basis. The calibrations indicated that the Amsler machine registered 0.9 per cent higher and the Olsen machine 0.1 per cent lower than the Riehlé machine.

Yield point loads were determined by the drop of beam or halt in pointer movement, and by the divider methods. In most tests the divider indication closely checked the load at drop of beam.

Speed of head for the Amsler machine was determined from measurements made immediately after the yield point had been determined.

Results of Tests.—The yield points by the drop of beam method for the individual tests have been plotted against speed of head in Fig. 1. In the tests of the two specimens on the Amsler machine at speeds of 4.33 and 7.50 in. per min. the pendulum surged so badly that the accuracy of the yield points is questionable. The average yield-point - speed curve for the specimens tested in the Amsler machine has the same shape but lies approximately 1 per cent higher than the curve for the specimens tested in Riehlé or Olsen machines. If allowance is made for the calibration discrepancy, the two curves practically coincide.

For purposes of comparison the yield-point - speed curve for the carbon steel rods of Series No. 261[1] has been drawn in the lower part of Fig. 1. The latter curve was obtained from 100 tests in five laboratories conducted on Riehlé or Olsen machines with capacities ranging from 60,000 to 200,000 lb. The shape of this lower curve is quite similar to the curves for specimens of Series No. 282. The differences in ordinates to the curves for the two series of tests is largely due to differences in yield points of the materials tested.

Summary.—From the data obtained in the tests of Series No. 282 it appears that the relationship of tensile yield point by drop of beam to speed of movable head of testing machine was approximately the same for both the screw-gear-driven lever machines and the hydraulic machine. The shape of the curve showing this relationship is substantially the same as that obtained for similar material tested in Series No. 261.

This report has been submitted to letter ballot of the committee, which consists of 8 members; 7 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

M. O. WITHEY,
Chairman.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 109 (1928).

DISCUSSION

Mr. H. E. Smith.[1]—The usual method of reporting the speed of a testing machine is to give the free running speed of the cross-head. In another committee, some experiments have been made on the actual speed within the yield point, where it is found to be a very small fraction of the free running speed. This report gives us the speed beyond the yield point, while the mass is stretching. Can we have any information of the ratio between that and the free running speed?

Mr. M. O. Withey[2] (*Chairman, Research Committee on Yield Point of Structural Steel*).—The speeds indicated in Fig. 1 for the Riehlé and Olsen machines were the free running speeds. For the Amsler machine they were determined after the material had passed the yield point. We did not secure information giving the relation of the actual stretching on the specimen to the free running speed of the head.

Mr. T. D. Lynch.[3]—In connection with some tests being made for Sub-Committee VI on Forgings of Committee A-1 on Steel, we made some pretty careful investigations of the relation between the speed of elongation of the 2-in. gage length of the test specimen and the movement of the head of the machine running idle. These tests were made on an Amsler machine and a screw machine at the Westinghouse Laboratory, screw machines at the laboratories of the Pennsylvania Railroad and the Standard Steel Works and the ratios found between the 2-in. gage length speed and the head of the machine running idle were as follows: the Amsler hydraulic machine at the Westinghouse Laboratory, ratio 26 to 1, that is, the movement of the head of the machine was 26 times as great as the stretch of the 2-in. gage length of the test sample, the screw machine at the Pennsylvania Railroad Laboratory 19 to 1, the screw machine at the Standard Steel Works Laboratory 15 to 1 and the screw machine at the Westinghouse Laboratory 20 to 1; showing the great variety of differences between the speeds of the head of the testing machine and the stretching of the test specimen itself, which is really the thing we are interested in. Committee E-1 on Methods of Testing is forming a section to make a further study of this subject. I think that by another year there will be some very good information presented to the Society on this subject, in addition to the work Mr. Withey is doing, and which I think is a very valuable addition to the data we now have.

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[1] Engineer of Materials, New York Central Lines, New York City.

[2] Professor of Mechanics, University of Wisconsin, Madison, Wis.

[3] Consulting Metallurgical Engineer, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

REPORT OF COMMITTEE A-2

ON

WROUGHT IRON

During the past year Committee A-2 held one meeting, on March 19, 1929. A second meeting will be held prior to the presentation of this report to the Society at which the report will be reviewed and other matters considered.

Recommendations Affecting Standards

The committee recommends that the revisions in the following standards, which are shown in detail in the Appendix to this report, be accepted for publication as tentative:

Standard Specifications for Welded Wrought-Iron Pipe (A 72 – 27);

Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 – 27);

Standard Specifications for Staybolt, Engine-Bolt and Extra-Refined Wrought-Iron Bars (A 84 – 27);

Standard Specifications for Hollow Rolled Staybolt Iron (A 86 – 27).

The above recommendations have been referred to letter ballot of the committee which consists of 58 members; 35 ballots have been cast, 23 members having failed to return their ballots. The analysis of the vote of the committee is given in the following table:

Items	Affirmative	Negative	Not Voting
I. Tentative Revisions of Existing Standards			
A 72 – 27 Specifications for Welded Wrought-Iron Pipe	30	2	6
A 83 – 27 Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes	32	2	4
A 84 – 27 Specifications for Staybolt, Engine-Bolt and Extra-Refined Wrought-Iron Bars	34	2	2
A 86 – 27 Specifications for Hollow Rolled Staybolt Iron	29	2	7

Sub-Committee Activities

Sub-Committee I on Pipe and Tubes—(G. H. Woodroffe, chairman).—This sub-committee is recommending revisions in the Standard

Specifications for Welded Wrought-Iron Pipe (A 72 - 27). These revisions include broadening the scope of the specifications and other changes to make them agree in form with the Standard Specifications for Welded and Seamless Steel Pipe (A 53 - 27).

The sub-committee is joining with Sub-Committee IX of Committee A-1 in recommending revisions in the Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 - 27). These changes affect Table II on weights of small superheater tubes, to which have been added weights of four additional gages lighter than No. 14 B.w.g., and includes also a revision of the workmanship clause defining the tolerance of the outside diameter of boiler tubes.

Sub-Committee III on Staybolt and Engine-Bolt Iron (E. J. Edwards, chairman).—This sub-committee is recommending a revision of the definition of "box pile" in the Standard Specifications for Staybolt, Engine-Bolt and Extra-Refined Wrought-Iron Bars (A 84 - 27), as well as in Standard Specifications for Hollow Rolled Staybolt Iron (A 86 - 27). In the latter specifications it is also recommended that the requirement for reduction of area be increased from 42 per cent to 48 per cent.

Sub-Committee VI on Wrought-Iron Blooms and Forgings (H. E. Smith, chairman).—The sub-committee has had under consideration a proposal to investigate the relative merits of rolling, pressing and hammering for the manufacture of large sizes of wrought-iron blooms and forgings. It has been decided, however, that it will be difficult to exclude all other variables and that a sufficiently comprehensive program would be costly and might involve commercial complications. The sub-committee recommends therefore that the project be dropped.

Sub-Committee IX on Methods of Chemical Analysis of Wrought Iron (G. E. F. Lundell, chairman).—The sub-committee is developing methods for the determination of slag in wrought iron and is also working on a satisfactory method for the determination of phosphide phosphorus. The work is not sufficiently advanced to be included with this report.

Sub-Committee X on Research (H. W. Faus, chairman).—This sub-committee is engaged in the important study of what constitutes quality in wrought iron. Questionnaires will soon be sent to producers and consumers of wrought iron who are in a position to contribute information to the committee. Members of Committee A-2 who receive such questionnaries are urged to make complete replies in order that the work may be as comprehensive and authentic as possible.

A section of Sub-Committee X, under the chairmanship of Mr.

J. H. Higgins, has recently completed the tests in connection with the investigation undertaken to determine the effect of phosphorus in staybolt iron. The results were not available in time to be summarized for inclusion with this report but will form an important part of the report for 1930.

During the year, Committee A-2 has given consideration to the possibility of revising the process clauses of wrought-iron specifications to insure material of highest quality without restriction as to the process of manufacture. However, no definite action can be reported this year.

This report has been submitted to letter ballot of the committee, which consists of 58 members; 33 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

H. W. FAUS,
Chairman.

G. H. WOODROFFE,
Secretary.

EDITORIAL NOTE

The proposed tentative revisions of the Standard Specifications for Welded Wrought-Iron Pipe; for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes; for Staybolt, Engine-Bolt and Extra-Refined Wrought-Iron Bars; and for Hollow Rolled Staybolt Iron were accepted for publication as tentative and appear on pages 856 855 and 857.

PROPOSED REVISIONS IN STANDARD SPECIFICATIONS FOR WROUGHT IRON

In this appendix are given proposed revisions in certain standard specifications. In connection with each title is given the reference to the publication in which the specifications appear in their present form.

Proposed Tentative Revisions of Standards

Standard Specifications for Welded Wrought-Iron Pipe (A 72 – 27)[1]:

Section 1.—Add two sentences at the end of this section to read as follows:

> Pipe ordered under these specifications is intended for coiling, bending, flanging and other special purposes. Butt-welded pipe is not intended for flanging and is not recommended for bending or coiling in sizes 1¼ in. or over.

Section 2.—Omit this section, reading as follows, and renumber the subsequent sections accordingly:

> 2. All pipes to be used on locomotives and cars shall be of coiling or bending quality.

Section 8.—Add a sentence at the end of this section to read as follows:

> Double-extra-strong pipe over 1¼ in. in nominal size need not be subjected to the bend test.

Section 10.—Change Paragraph (*a*) from its present form: namely,

> (*a*) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

to read as follows:

> (*a*) Tension test specimens may be of full section or strips cut longitudinally from the pipe. The sides of specimens shall be parallel and not flattened between gage marks.

Omit Paragraph (*b*), reading as follows, and reletter the present Paragraph (*c*) to read Paragraph (*b*):

> (*b*) Tension test specimens shall be longitudinal.

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 377.

Section 16.—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

16. For pipe $1\frac{1}{2}$ in. or under in [inside diameter] *nominal size,* the outside diameter at any point shall not vary more than $\frac{1}{64}$ in. over nor more than $\frac{1}{32}$ in. under the standard [size] *outside diameter.* For pipe 2 in. or over in [inside diameter] *nominal size,* the outside diameter shall not vary more than 1 per cent over or under the standard [size] *outside diameter.*

Section 17 (c).—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

(*c*) All threads shall be in accordance with the American Standard *Pipe Thread*[a] and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. [The variation from the standard, when tested with the standard working gage, shall not exceed a maximum of one and one-half turns either way.]

Change the footnote from its present form: namely,

[a]A complete description of the American Standard Pipe Thread is contained in the Pipe Thread Standard prepared under the sponsorship of the American Gas Association and the American Society of Mechanical Engineers and approved as American Standard by the American Engineering Standards Committee.

to read as follows:

[a]A complete description of American Standard Pipe Threads applicable to pipe, valves and fittings, is contained in the Pipe Thread Bulletin published by the American Standards Association.

Standard Specifications for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (A 83 – 27):[1]

Section 16. (a).—Change from its present form: namely,

16. (*a*) Finished tubes 4 in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over 4 in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter.

to read as follows:

16. (*a*) The outside diameter of finished tubes shall not vary more than $\frac{1}{64}$ in. over the size ordered. For finished tubes up to and including 4 in. in outside diameter, the outside diameter shall not vary more than $\frac{1}{32}$ in. under the size ordered, and for tubes over 4 in. in outside diameter, the outside diameter shall not vary more than $\frac{3}{64}$ in. under the size ordered.

Table II.—Change the table from its present form by the addition of weight requirements for four additional thicknesses, lighter than

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 242.

No. 14 gage and additional weight requirements for sizes $\frac{5}{8}$ to $\frac{7}{8}$ in. inclusive of tubes of thicknesses No. 14 gage and heavier, as indicated in italics in the accompanying Table I:

TABLE I.—STANDARD WEIGHTS OF SMALL SUPERHEATER TUBES.

SEAMLESS ONLY

THICKNESS		WEIGHT, LB. PER FT. OF LENGTH				
		OUTSIDE DIAMETER, IN.				
B.W.G.	IN.	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{3}{16}$	$\frac{7}{8}$
18	*0.049*	*0.301*	*0.334*	*0.367*	.....	.....
17	*0.058*	*0.351*	*0.390*	*0.429*	.....	.....
16	*0.065*	*0.389*	*0.432*	*0.476*	.....	.....
15	*0.072*	*0.425*	*0.473*	*0.521*	.....	.....
14	0.083	0.480	0.535	*0.591*	*0.647*	*0.702*
13	0.095	0.537	0.601	0.664	0.727	*0.791*
12	0.109	*0.600*	*0.673*	0.746	0.818	0.891
11	0.120	*0.647*	*0.717*	*0.807*	0.887	0.967
10	0.134	*0.702*	*0.792*	*0.881*	*0.971*	1.060
9	0.148	.....	.....	.....	.....	*1.149*

Standard Specifications for Staybolt, Engine-Bolt and Extra-Refined Wrought-Iron Bars (A 84 – 27):[1]

Section 3 (c).—Change to read as follows by the omission of the words in brackets:

> (*c*) *Box Pile.*—A box pile is a pile, the sides [top and bottom] of which are formed by [four] flat bars and the interior of which consists of a number of small bars the full length of the pile.

Standard Specifications for Hollow Rolled Staybolt Iron (A 86 – 27):[2]

Section 2 (c).—Change to read as follows by the omission of the words in brackets:

> (*c*) *Box Pile.*—A box pile is a pile, the sides [top and bottom] of which are formed by [four] flat bars and the interior of which consists of a number of small bars the full length of the pile.

Section 5 (a).—Change the minimum requirement for reduction of area from 42 per cent to 48 per cent.

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 381.

[2] *Ibid.*, p. 386.

REPORT OF SECTIONAL COMMITTEE ON STANDARDIZATION OF DIMENSIONS AND MATERIAL OF WROUGHT IRON AND WROUGHT STEEL PIPE AND TUBING

The Sectional Committee on Standardization of Wrought-Iron and Wrought-Steel Pipe and Tubing, functioning under the procedure of the American Standards Association, has been organized during the year under the joint sponsorship of the American Society of Mechanical Engineers and the American Society for Testing Materials. Sub-committee and general committee meetings have been held and considerable progress has been made during the year.

The only definite recommendation being made at this time is the submission for consideration as an American Tentative Standard of a table of dimensions and weights of lap-welded and seamless steel pipe for high-temperature service, appended hereto. This recommendation was unanimously approved at a meeting of the sectional committee held in March, 1929, and has subsequently been submitted to letter ballot of the committee, which consists of 36 members; 29 members returned their ballots, of whom 27 have voted affirmatively, 1 negatively and 1 has marked his ballot not voting.

The table of dimensions and weights has been developed for the immediate relief of an industry and will be subject to change as the work of the sectional committee develops. It has been accepted by Committee A-1 on Steel of the American Society for Testing Materials and is being recommended by that committee for incorporation in its Tentative Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service (A 106 – 28 T), being recommended for advancement to standard this year.

The recommendation for the consideration of the table is reported to the sponsor bodies for such action as may seem desirable in order to give the table official standing.

Respectfully submitted on behalf of the sectional committee,

H. H. Morgan,
Chairman.

Sabin Crocker,
Secretary.

APPENDIX

TABLE I.—DIMENSIONS AND WEIGHTS OF LAP-WELDED AND SEAMLESS STEEL PIPE[a] FOR HIGH-TEMPERATURE SERVICE.[b]

250, 400, 600, 900, AND 1350 LB. PER SQ. IN., WORKING STEAM PRESSURE RATINGS

Working Steam Pressure Rating[c].		250 lb.		400 lb.		400 lb.		600 lb.		900 lb.		1350 lb.	
Hydrostatic Test[c]		750 lb.		1000 lb.		1000 lb.		1500 lb.		2000 lb.		3000 lb.	
Nominal Pipe Size, in.	Outside Diameter, in.	Wall Thickness,[d] in.	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness,[d] in.	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness,[d] in.	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness,[d] in.	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness,[d] in.	Weight per Linear Foot, Plain Ends, lb.	Wall Thickness,[d] in.	Weight per Linear Foot, Plain Ends, lb.
		SEAMLESS LOW OR MEDIUM-CARBON PIPE											
$\frac{1}{2}$	0.840	0.109	0.850	....	....	0.109	0.850	0.147	1.087	0.147	1.087	0.147	1.087
$\frac{3}{4}$	1.050	0.113	1.130	....	....	0.113	1.130	0.154	1.473	0.154	1.473	0.1875	1.727
1	1.315	0.133	1.678	....	....	0.133	1.678	0.179	2.171	0.179	2.171	0.21875	2.561
$1\frac{1}{4}$	1.660	0.140	2.272	....	....	0.140	2.272	0.191	2.996	0.191	2.996	0.250	3.764
$1\frac{1}{2}$	1.900	0.145	2.717	....	....	0.145	2.717	0.200	3.631	0.200	3.631	0.28125	4.862
		LAP-WELDED OPEN-HEARTH				SEAMLESS LOW OR MEDIUM-CARBON PIPE							
2	2.375	0.154	3.652	0.218	5.022	0.167	3.938	0.1875	4.380	0.250	5.673	0.3125	6.883
$2\frac{1}{2}$	2.875	0.203	5.793	0.276	7.661	0.203	5.793	0.217	6.160	0.276	7.661	0.375	10.01
3	3.500	0.216	7.575	0.300	10.25	0.216	7.575	0.241	8.388	0.3125	10.64	0.40625	13.42
$3\frac{1}{2}$	4.000	0.226	9.109	0.318	12.51	0.226	9.109	0.28125	11.17	0.34375	13.42	0.46875	17.68
4	4.500	0.237	10.79	0.337	14.98	0.237	10.79	0.28125	12.67	0.375	16.52	0.500	21.36
5	5.563	0.258	14.62	0.375	20.78	0.258	14.62	0.352	19.59	0.4375	23.95	0.625	32.96
6	6.625	0.280	18.97	0.432	28.57	0.288	19.49	0.385	25.66	0.500	32.71	0.6875	43.60
8	8.625	0.322	28.55	0.500	43.39	0.34375	30.40	0.46875	40.83	0.625	53.40	0.875	72.42
10	10.75	0.365	40.48	0.500	54.74	0.395	43.68	0.53125	57.98	0.750	80.10	1.0625	109.9
12	12.75	0.375	49.56	0.500	65.42	0.500	65.42	0.625	80.94	0.875	111.0	1.21875	150.1
14	14.0	0.40625	58.98	0.625	89.28	0.500	72.09	0.65625	93.52	0.9375	130.8	1.34375	181.6
16	16.0	0.46875	77.75	0.6875	112.4	0.53125	87.77	0.750	122.2	1.03125	164.9	1.500	232.3
18	18.0	0.500	93.45	0.750	138.2	0.59375	110.4	0.8125	149.1	1.15625	208.0	1.6875	294.0
20	20.0	0.5625	116.8	0.875	178.7	0.625	129.3	0.90625	184.8	1.28125	256.1	1.84375	357.5
24	24.0	0.625	156.0	0.9375	230.9	0.750	186.2	1.03125	253.0	1.500	360.5	2.1875	509.6

[a] While the thicknesses given in this table are theoretically ample to care for both bursting pressure and material removed in threading, it is recommended that where pipe is threaded, a weight at least equal to the 900-lb. class be used to furnish added mechanical strength.

[b] This contemplates temperatures from 450 to 750° F. (230 to 400° C.), or at the discretion of the designing engineer, higher temperatures with appropriate pressures may be used.

[c] All pressures in pound per square inch gage.

[d] Wall thicknesses calculated from the modified Barlow formula given in Paragraph P-23 of the 1927 Edition of the A.S.M.E. Boiler Construction Code (as revised), increased to provide 12.5 per cent under thickness mill tolerance, then chosen as the next heavier commercial wall thickness.

REPORT OF COMMITTEE A-3
ON
CAST IRON

Since the 1928 annual meeting of the Society, Committee A-3 has held two meetings, one an informal meeting on October 9, 1928, during the convention of the American Society for Steel Treating at Philadelphia, and the other at Chicago on March 20, 1929. A third meeting will be held prior to the presentation of this report to the Society, at which time the report will be reviewed and other matters considered.

The present membership of the committee is 81, of which 31 are classified as producers, 31 as consumers, and 19 as general interests.

The committee adopted resolutions in memory of the late Jesse L. Jones, who was for many years a very active member of the committee and who passed away during the year.

RECOMMENDATIONS AFFECTING STANDARDS

In 1927,[1] Committee A-3 recommended revisions in the following standards:

Standard Specifications for Gray-Iron Castings (A 48 – 18);

Standard Specifications for Cast-Iron Soil Pipe and Fittings (A 74 – 18);

Standard Specifications for High-Test Gray-Iron Castings (A 88 – 24).

These revisions consisted in a change in the arbitration test bar used for the transverse test and a change in the test bar used in the tension test for cast iron, as affecting these three specifications.

In 1928[2] the committee recommended the removal of the description of the test bars from these specifications and the publication of the Tentative Specifications for the Arbitration Test Bar and Tension Test Specimen for Cast Iron (A 124 – 28 T),[3] describing the transverse test bar and the tension test bar. This was a change in form and not in substance. The specifications and revisions remained tentative during 1928. The committee now recommends to the Society that the Tentative Specifications A 124 – 28 T and the tentative revisions in the three Standard Specifications, A 48, A 74 and A 88, be adopted as standard.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 167 (1927).

[2] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 139 (1928).

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 738 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 72.

Sub-Committee IV on Car Wheels has submitted new proposed Tentative Specifications for Chilled-Tread Cast-Iron Wheels as a complete revision of the present Standard Specifications for Chilled Cast-Iron Wheels (A 46 – 24).[1] The changes consist mainly in lowering the total carbon to conform to present manufacturing requirements and in minor changes to bring the specifications into conformity with the corresponding A.R.A. specification. The committee recommends that these proposed specifications, as appended hereto,[2] be accepted for publication as tentative to replace when adopted the present Standard Specification A 46-24.

Sub-Committee XVII on Valves and Fittings has submitted new proposed Tentative Specifications for Gray-Iron Castings for Valves, Flanges and Pipe Fittings. The need of standardizing these types of castings has been considered essential not only by the manufacturers but by consumers, particularly in the oil fields.

In December, 1927, the Sectional Committee on Pipe Flanges and Fittings functioning under the American Standards Association (formerly the A.E.S.C.) determined that a specification was desirable for gray iron for valves, flanges, and pipe fittings, since there were no specifications for cast iron for this product. The Society was asked to provide such specifications and through Sub-Committee XVII of Committee A-3 such specifications were drawn and accepted by Committee A-3 at its meeting held in March.

The request for these specifications stipulated that they should cover what may be called "stock" goods, that is, finished valves, flanges and pipe fittings (sometimes castings) of cast iron, manufactured in advance and supplied for sale from stock by the manufacturer, jobber, or other dealer. It is understood that test bars cannot well be attached to the product or supplied, any goods so furnished being considered "special," and that even test reports on each valve, flange or small pipe fitting cannot accompany it. The manufacturers of this class of product, however, usually put their names or recognized marks upon the various articles, this being considerable of a guarantee of quality. It happens also that practically all of these manufacturers are equipped with laboratories for chemical and physical tests and that the mixtures and melting usually are controlled by analyses.

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[1] 1927 Book of A.S.T.M. Standards, p. 432.

[2] See p. 574 —ED.

Because of these established favorable conditions and the fact that practically all of the manufacturers included, make, machine, and assemble their own products, it was possible to draw up the proposed specification. The chemical and physical requirements specified cover present high-quality practice in the gray-iron valve and fittings industry.

The specifications include the following requirements:

1. That materials made thereunder be produced under regular chemical and physical control;
2. That test bars be made according to predesigned pattern with rather closely specified gating, these test bars to be made at least twice during each period that iron on this specification is being run;
3. Since most, or probably all, of the manufacturers of this product base the strength of their castings in designing them on the tension test bar, requirements for the tension test are included upon the provision that the separately "cast-to-size" tension test bar be tested in a machine with shackles giving perfect alignment and freedom from transverse strains. Upon such basis, the tension test is fully as accurate as the transverse test.
4. The tension and transverse test bars are to be made from plate pattern, preferably on a standard molding machine from the same lot of sand and in the same general way as that in which molds for the castings are made. Bars shall be marked in the mold or afterward with proper designations and thorough records are to be maintained. Bars of this pattern and gating have been used for four years on regular production work and have been very satisfactory.
5. A certification clause is included so that a customer may request certification from the manufacturer that the product has been manufactured in accordance with the specifications.

The committee recommends that these proposed specifications, as appended hereto,[1] be accepted for publication as tentative.

SUB-COMMITTEE ACTIVITIES

Sub-Committee XIII on High-Test Cast Iron (J. W. Bolton, chairman).—This sub-committee is drawing up a recommended practice for low-carbon cast iron. A recommendation has been made that a closer and more definite classification of irons by classes (Classes 1, 2, 3, etc.) based on ranges of tensile strength be drawn up by Committee A-3, such classes to form a more definite basis for a suitable specification. It is necessary also to obtain more definite information from Sub-Committee XIV on Correlation of Test Bar and Casting before it will be possible to develop a suitable specification.

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[1] See p. 581.—ED.

Sub-Committee XIV on Correlation of Test Bar and Casting (R. S. MacPherran, chairman).—This sub-committee has been active and has obtained considerable data, some of which are included in Appendix I to this report. Since it is necessary to gather much additional information, attention is drawn to the resolution presented in this Appendix.

Sub-Committee XVI on Heat Treatment of Cast Iron (F. B. Coyle, chairman).—This sub-committee has performed considerable work during the year. The results of a questionnaire issued to representative industries and an outline of a digest of literature being prepared for presentation to the Society next year are given in the report of the sub-committee appended hereto.

The following is the result of the letter ballot of the committee on the recommendations made in this report.

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARDS			
Proposed Tentative Specifications for Gray-Iron Castings for Valves, Flanges and Pipe Fittings	39	0	9
II. PROPOSED TENTATIVE REVISIONS OF STANDARDS			
Standard Specifications for Chilled Cast-Iron Wheels (A 46 - 24)	34	0	14
III. ADVANCEMENT OF TENTATIVE STANDARD TO STANDARD			
Tentative Specifications for the Arbitration Test Bar and Tension Test Specimen for Cast Iron (A 124-28 T)	44	2	2
IV. ADVANCEMENT TO STANDARD OF TENTATIVE REVISIONS OF STANDARDS			
Standard Specifications for Gray-Iron Castings (A 48 - 18)	45	1	2
Standard Specifications for Cast-Iron Soil Pipe and Fittings (A 74 - 18)	35	0	13
Standard Specifications for High-Test Gray-Iron Castings (A 88 - 24)	42	2	4

This report has been submitted to letter ballot of the committee, which consists of 84 members; 48 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

HYMAN BORNSTEIN,
Chairman.

F. B. COYLE,
Secretary.

EDITORIAL NOTE

The proposed Tentative Specifications for Gray-Iron Castings for Valves, Flanges and Pipe Fittings were accepted for publication as tentative and appear on page 581.

The proposed Tentative Specifications for Chilled-Tread Cast-Iron Wheels were accepted for publication as tentative to supersede, when adopted, the present standard specifications. The tentative specifications appear on page 574.

The Tentative Specifications for the Arbitration Test Bar and Tension Test Specimen for Cast Iron were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 73.

The tentative revisions of the Standard Specifications for Gray-Iron Castings; for Cast-Iron Soil Pipe and Fittings; and for High-Test Gray-Iron Castings were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929. The standard specifications in their revised form appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 68, 64 and 71, respectively.

REPORT OF SUB-COMMITTEE XIV ON CORRELATION OF TEST BAR AND CASTING

In view of the present uncertainty of the physical values of cast iron as shown by the arbitration test bar which "represents only the iron in the ladle" and the information desired of those values as actually existing in the casting, the sub-committee appointed a section consisting of J. W. Bolton, E. J. Lowry and J. T. MacKenzie to draw up a resolution for submission to Committee A-3:

> WHEREAS it is realized that the present test bar indicates only the quality of iron in the ladle, and that the engineering and foundry fraternity needs more definite assurance of the properties of the metal in the casting, and further, that methods of taking tests directly from castings or from coupons attached thereto will lead to endless dispute within the trade, this sub-committee recommends that methods of correlation be investigated. Among the methods suggested, consideration of the relationship between cooling rate and properties of iron of given analysis and thermal history seems promising. This may be expressed by the relation of volume to surface area. It is further recommended that a series of tests be devised to establish relations of various castings and test bars with the same volume to surface area ratio.

Accordingly, it is recommended that the members of Committee A-3 take certain simple castings, determine their cooling rate and compare the properties of various portions with the properties of test bars of similar composition and cooling rate as shown in Table II of a paper by J. W. Bolton, presented before the American Foundrymen's Association in 1928.[1] The relative rates of cooling of test bars of castings should be determined by means of pyrometers and this data as well as all other pertinent data should be submitted to the chairman.

The following has been submitted by F. B. Coyle, a member of the sub-committee, as of possible interest regarding the relation of strength to section of casting.

The 1928 Report of Committee A-3 contained results of tests on bars of different sizes.[2] These are reproduced in the accompanying Fig. 1. Curve *A* is from the average of Jones' iron series Nos. 1, 2 and 3. Curve *B* is from iron No. 4, which was higher in silicon.

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[1] *Transactions*, Am. Foundrymen's Assn., p. 476 (1928).

[2] Report on Correlation Tension and Transverse Tests of Cast Iron, Appendix, Report of Committee A-3 on Cast Iron, *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 142 (1928).

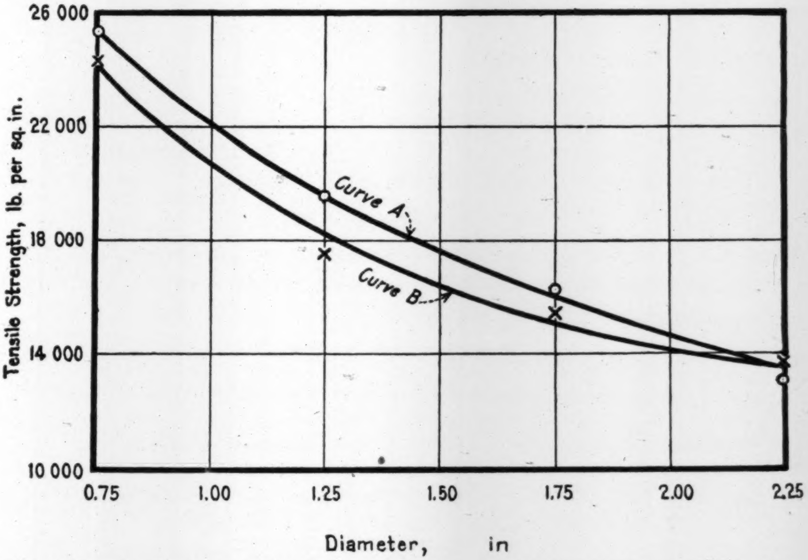

FIG. 1.—Curves Showing Relation Between Average Tensile Strength of Test Bars of Various Diameters.

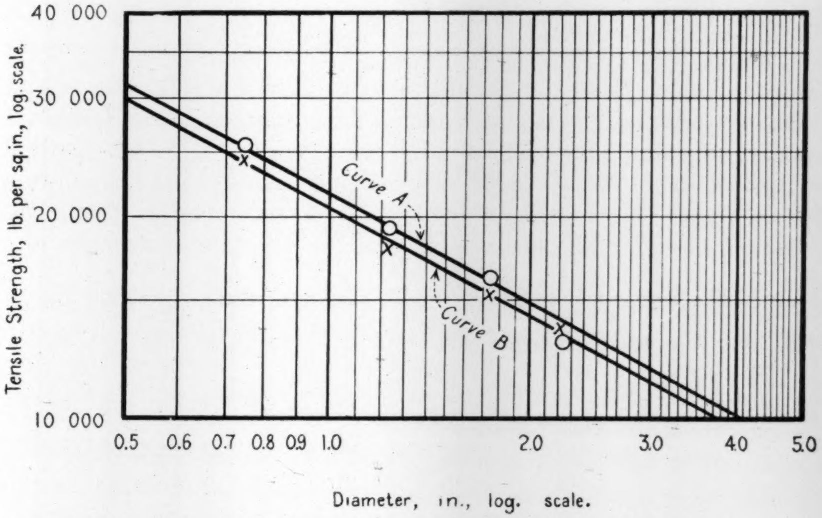

FIG. 2.—Logarithmic Plot of Curves *A* and *B* Shown in Fig. 1.

Inspection of these curves show them to be of the type:

$$y = cx^{m} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which y = tensile strength,
c = a constant,
x = diameter of casting, and
m = an exponent.

This equation can also be expressed in logarithmic form as follows:

$$\log y = m \log x + \log c \ldots\ldots\ldots\ldots\ldots (2)$$

When Eq. 1 is plotted on logarithmic cross-section paper, the graph is a straight line, since Eq. 2 is then a standard form of a straight-line equation:

$$y = mx + k \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

TABLE I.—RESULTS OF TESTS ON CAST IRON BARS OF VARIOUS DIAMETERS.

Material	Chemical Composition, per cent					Tensile Strength, lb. per sq. in.							
	Total Carbon	Manganese	Phosphorus	Sulfur	Silicon	$\frac{3}{4}$-in. Bar	$1\frac{1}{4}$-in. Bar	$1\frac{3}{4}$-in. Bar	2-in. Bar	$2\frac{1}{4}$-in. Bar	$2\frac{3}{4}$-in. Bar	$3\frac{1}{4}$-in Bar	4-in. Bar
D[a]	3.43	0.53	0.21	0.091	1.11	42 170	34 600	27 800	24 470	.....	.....	.....	.....
F[b]	3.60	0.78	0.21	0.121	1.29	.....	30 500	26 500	.....	23 500	21 250	19 750	19 250
A[c]	3.62	0.66	0.37	0.076	2.12	25 360	19 450	16 200	.....	13 040	.....	.....	.....
E[d]	3.42	0.70	0.54	0.084	2.23	.....	20 750	17 000	.....	15 000	14 250	14 000	13 500
C[e]	3.42	0.54	0.65	0.089	2.32	28 100	21 140	16 770	.....	13 570	.....	.....	.....
B[f]	3.47	0.70	0.37	0.092	2.49	24 250	17 380	15 310	.....	13 560	.....	.....	.....

[a] Data by R. S. MacPherran, Material A 1928 report of Committee A-3.[1]
[b] Data by R. S. MacPherran, private communication Material A.
[c] Data by J. L. Jones, 1928 report of Committee A-3.[2]
[d] Data by R. S. MacPherran, private communication Material C.
[e] Data by R. S. MacPherran, Material C 1928 report of Committee A-3.[1]
[f] Data by J. L. Jones, 1928 report of Committee A-3.[2]

This is demonstrated by the plot of both curves of Fig. 1 in Fig. 2. From the plots on logarithmic paper it is an easy matter to derive the proper values for the constant c and the exponent m. The exponent m is the slope of the curve (in this case negative since the graph dips to the right). If x is made equal to 1 then x^m equals 1 and the constant $c = y$ or, in this case, is equal to the tensile strength of a 1-in. round bar. The slope of the curve, m, is equal to: $-\frac{1}{2.02}$.

Then Eq. 1 takes the form:

$$y = cx^{\left(-\frac{1}{2.02}\right)} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

which can also be expressed as

$$y = \frac{c}{x^{\left(\frac{1}{2.02}\right)}} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Table I contains Jones' data supplemented by that from the laboratory of the International Nickel Co. This data is plotted on Figs.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 144 (1928).
[2] *Ibid.*, p. 142.

3 and 4. The equations for the six irons given are as follows, in which d represents the diameter of the test bar:

Material A.............. $y = \frac{22\,000}{d^{(\frac{1}{2.02})}}$ .... (6)

Material B.............. $y = \frac{20\,600}{d^{(\frac{1}{2.02})}}$ .... (7)

Material C.............. $y = \frac{23\,750}{d^{(\frac{1}{2.02})}}$ .... (8)

Material D.............. $y = \frac{37\,500}{d^{(\frac{1}{2.02})}}$ .... (9)

Material E.............. $y = \frac{23\,100}{d^{(\frac{1}{2.02})}}$ .... (10)

Material F.............. $y = \frac{34\,000}{d^{(\frac{1}{2.02})}}$ .... (11)

Table II.—Constants to be Used in Equations for Relation of Strength to Section of Round Cast-Iron Bars.

Silicon, per cent	Total Carbon, per cent												
	2.50	2.60	2.70	2.80	2.90	3.00	3.10	3.20	3.30	3.40	3 50	3.60	3.70
1.00	.....	.....	.....	.....	.....	42 300	41 000	39 400	37 800	36 500	35 200	33 850	32 500
1.10	.....	.....	.....	.....	.....	44 400	42 800	41 250	39 400	37 300	35 550	33 300	30 950
1.20	.....	.....	.....	.....	.....	45 000	43 400	41 800	39 700	37 550	35 550	33 300	30 700
1.30	.....	.....	.....	45 500	45 000	44 200	42 800	40 700	38 600	35 700	33 050	30 150	27 500
1.40	.....	.....	.....	45 000	42 300	42 800	41 250	38 900	36 000	33 050	30 400	26 500	25 900
1.50	42 300	44 400	45 000	44 400	43 100	41 250	39 400	37 000	34 400	31 750	29 350	27 000	24 850
1.60	41 500	43 600	44 200	43 400	41 800	39 950	37 800	36 500	31 250	30 400	28 300	25 900	23 800
1.70	40 700	42 300	42 800	41 800	40 200	38 100	36 000	33 050	31 150	29 100	27 000	23 750	23 300
1.80	39 700	40 700	41 000	40 200	38 350	36 500	34 400	32 500	30 150	28 000	25 900	24 050	22 200
1.90	39 400	39 700	39 700	38 600	37 000	35 200	33 300	31 150	29 100	27 250	23 750	23 300	21 700
2.00	38 900	38 600	37 800	36 500	35 200	33 600	31 750	30 150	28 000	26 200	24 350	22 500	20 900
2.10	38 350	37 550	36 750	35 550	33 850	32 500	30 950	29 100	27 250	25 400	23 800	21 950	20 350
2.20	37 550	36 750	35 700	34 400	33 050	31 750	30 150	28 300	26 450	24 850	23 300	21 400	19 850
2.30	37 300	36 300	34 900	33 600	32 300	30 700	29 100	27 500	25 900	24 050	22 750	20 900	19 300
2.40	36 750	35 550	34 400	32 800	31 450	29 900	28 300	26 700	25 050	23 550	22 200	20 350	18 800
2.50	36 500	34 900	33 300	32 000	30 400	29 100	27 500	25 900	24 350	23 000	21 700	20 100	18 500

An inspection of these constants shows a marked consistency with the strength diagram shown as Fig. 1 of a discussion presented before the Society in 1927.[1] This diagram is based on 1¼-in. arbitration test bars. From it by conversion through Eq. 1, a table of constants was constructed which is given in Table II. The constants are listed for differences of 0.10 per cent in total carbon and 0.10 per cent in silicon. The following table shows how the constants determined experimentally compare with those estimated:

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[1] Discussion by F. B. Coyle of paper by M. E. Greenhow, "High-Test Alloy Cast Iron," *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part II, p. 84 (1927).

	CONSTANT DETERMINED EXPERIMENTALLY	CONSTANT ESTIMATED
Material A	22 000	21 950
Material B	20 700	21 700
Material C	23 750	24 050
Material D	37 500	37 300
Material E	23 100	24 450
Material F	34 000	30 150

The agreement in all cases except that of material F is considered noteworthy. In the case of material F a slight discrepancy in reporting total carbon or silicon may account for the disagreement. The estimated constants were substituted in Eqs. 6 to 11 and the results obtained are shown in Table III in comparison with the experimental results, and are also plotted on Figs. 3 and 4. The agreement, with the exception of material F, is considered extremely close.

TABLE III.—COMPARISON OF TENSILE STRENGTHS OF CAST-IRON BARS AS DETERMINED EXPERIMENTALLY AND BY CALCULATION.

		Total Carbon, per cent	Silicon, per cent	Tensile Strength, lb. per sq. in.							
				$\frac{3}{4}$-in. Bar	$1\frac{1}{4}$-in. Bar	$1\frac{3}{4}$-in. Bar	2-in. Bar	$2\frac{1}{4}$-in. Bar	$2\frac{3}{4}$-in. Bar	$3\frac{1}{4}$-in. Bar	4-in. Bar
Material D	experimental...	3.43	1.11	42 170	34 600	27 800	24 470	.....	.....	.....	.....
	calculated.....			43 070	33 400	28 300	24 800	.....	.....	.....	.....
Material F	experimental...	3.60	1.29	.....	30 500	26 500	.....	23 500	21 250	19 750	19 250
	calculated.....			.....	27 000	22 800	.....	20 200	18 250	16 800	15 200
Material A	experimental...	3.62	2.12	25 360	19 450	16 200	.....	13 040	.....	.....	.....
	calculated.....			25 350	19 700	16 630	.....	14 700	.....	.....	.....
Material E	experimental...	3.42	2.23	.....	20 750	17 000	.....	15 000	14 250	14 000	13 500
	calculated.....			.....	21 750	18 500	.....	16 300	14 800	13 600	12 300
Material C	experimental...	3.42	2.32	28 100	21 140	16 770	.....	13 570	.....	.....	.....
	calculated.....			27 800	21 500	18 200	.....	16 100	.....	.....	.....
Material B	experimental...	3.47	2.49	24 250	17 380	15 310	.....	13 560	.....	.....	.....
	calculated.....			23 900	19 430	16 360	.....	14 100	.....	.....	.....

At the suggestion of Mr. MacPherran, the equation was applied to the data presented in the paper by J. W. Bolton referred to previously. Four groups (Nos. 3, 4, 13 and 18) contained sufficient data. These were further subdivided according to pouring temperature as shown in the following table:

MATERIAL NO.	POURING TEMPERATURE, DEG. FAHR.
No. 3	2750
No. 4 (*a*)	2650
No. 4 (*b*)	2700
No. 13 (*a*)	2650
No. 13 (*b*)	2850
No. 18	2700

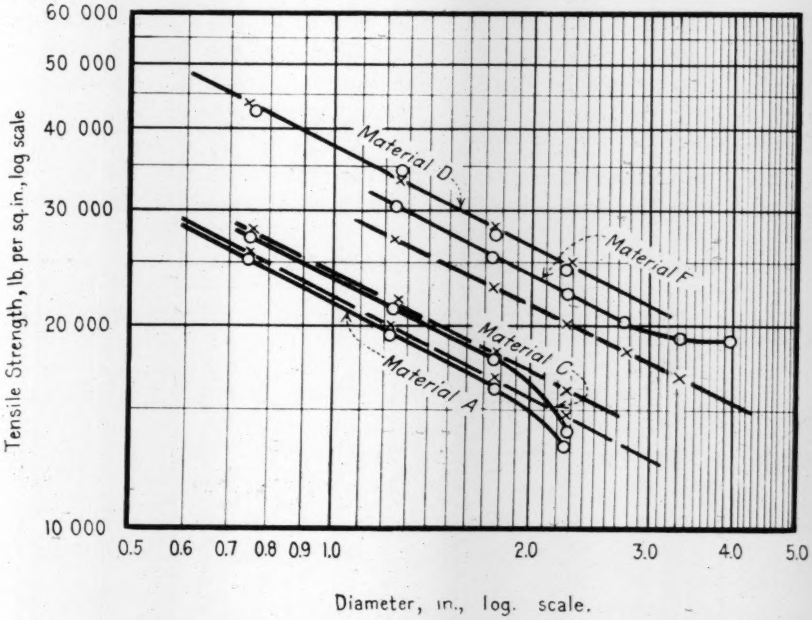

FIG. 3.—Curves Showing Relation Between Experimental and Estimated Constants for Various Materials.

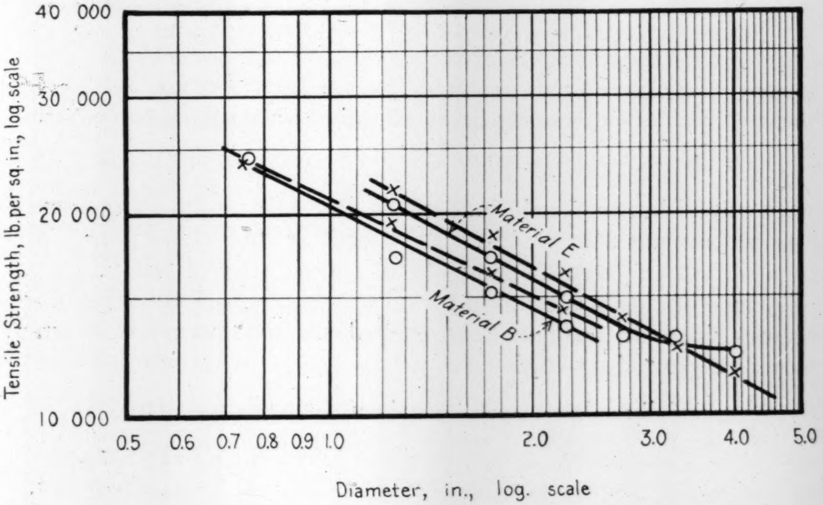

FIG. 4.—Curves Showing Relation Between Experimental and Estimated Constants for Various Materials.

The curves for these irons are plotted in Fig. 5. The curves for materials Nos. 3, 4(*b*) and 18 are parallel but the slope is steeper than that determined by Eq. 5. The slope of No. 13(*b*) is about the same as that determined by Eq. 5, while the slope of No. 13(*a*) is considerably less. The various points of this set of curves vary considerably more than those of other investigators, and in the case of material 4(*a*) the true slope is only a guess. However, if Eq. 5 is applied to all but material No. 3 of Mr. Bolton's results all the actual tests on sections 3 in. or less will be greater than those found from the equation and would amount to an added factor of safety.

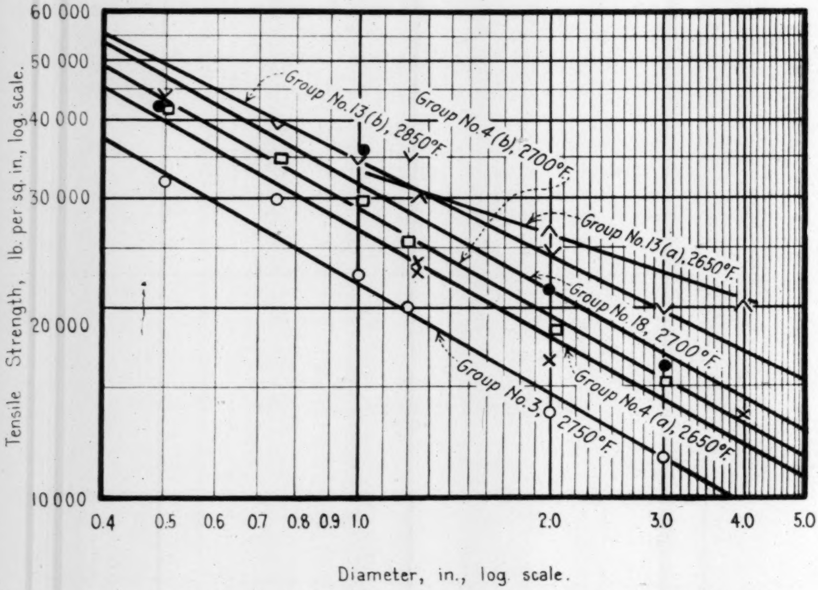

FIG. 5.—Curves Showing Relation Between Tensile Strength of Test Bars of Various Diameters.

The equation is submitted for criticism and check by other investigators since the data already studied are too meager to warrant drawing a general conclusion.

Respectfully submitted on behalf of the sub-committee,

R. S. MACPHERRAN,
Chairman.

REPORT OF SUB-COMMITTEE XVI ON HEAT TREATMENT OF CAST IRON

During 1928, a questionnaire was sent to about 300 leading manufacturers in several representative industries throughout the United States using cast iron. The following questions were presented:

1. Do you heat treat cast iron in any manner?
2. Do you heat treat cast iron for any of the following specific purposes:
    (*a*) Aging for relieving casting strains,
    (*b*) Softening for machining,
    (*c*) Altering physical properties such as strength, hardness, deflection, resistance to wear, etc.?
3. Do you heat treat cast iron for any other purpose?
4. If possible, without revealing trade secrets, will you kindly furnish as detailed information as is practicable of the process of heat treating cast iron and the results obtained, particularly with reference to:
    (*a*) Composition of material,
    (*b*) Method of treatment,
    (*c*) Temperatures used,
    (*d*) Properties obtained?
5. Do you know of any articles concerning the heat treatment of cast iron which have been published in unusual or obscure periodicals, books, etc.?

Replies were received from 69 manufacturers which can be classified as follows:

1. With definite information (some replies were quite extensive)	32
2. Use natural aging	3
3. Did not heat treat cast iron but were anxious to learn results and possibilities	11
4. Did not heat treat cast iron but would be glad to be of possible service in aiding the committee in any manner	2
5. Not interested	21
	69

The foregoing shows that of the replies received 68 per cent were at least interested in the industrial application of heat treatment to cast iron. This would indicate that the subject is of definite interest to at least 20 per cent of the industries using cast iron.

In Table I is given a summary of the data received through the questionnaire regarding the annealing of cast iron for softening to facilitate machining. All replies stated that combined carbon, strength and hardness were greatly reduced. When annealing was conducted to facilitate machining, strength of the part was not an important factor.

TABLE I.—SOFTENING CAST IRON BY ANNEALING TO FACILITATE MACHINING.

Reply	Temperature, deg. Fahr.	Time at Temperature, hours	Chemical Composition					Remarks
			Total Carbon, per cent	Manganese, per cent	Phosphorus, per cent	Sulfur, per cent	Silicon, per cent	
No. 1...	1100 to 1200	?		various	various			Chilled rolls
No. 2...	1200 to 1250	?		various	various			Miscellaneous castings
No. 3...	1400	depends on size	....	0.60 to 0.90	0.20 to 0.40	0.07 to 0.10	1.50	Large press frames and miscellaneous castings
No. 4...	1400	1	3.25 to 3.42	0.45 to 0.75	0.17 to 0.30	0.075to0.10	1.88 to 2.25	Pistons
No. 5...	1400 to 1450	1½	3.25 to 3.50	0.50 to 0.60	0.20 to 0.30	0.075to0.10	2.10 to 3.25	Pistons
No. 6...	1420 to 1475	varies		various	various			Miscellaneous castings
No. 7...	1450	1	3.40	0.65	0.65	0.09	2.80	Small castings in boxes
No. 8...	1450	2	3.50	0.70	0.40	0.10	2.50	Typewriter parts
No. 9...	1450	1 to 2		various	various			Miscellaneous castings
No. 10..	1500	5		various	various			Small castings
No. 11..	1500	½	....	0.40 to 0.80	0.20 to 0.55	0.08 to 0.13	1.30 to 2.30	Miscellaneous castings
No. 12..	1540	varies	3.55	0.54	0.58	0.078	2.42	Miscellaneous castings
No. 13..	1600	varies		gray iron	gray iron			Knitting machine parts
No. 14..	1600 to 1800	varies	3.40 to 3.70	0.50 to 0.70	0.40 to 0.80	0.05 to 0.08	1.60 to 2.00	Centrifugal pipe
No. 15..	1300 to 1650	3	3.00 to 3.25	0.40 to 0.60	under 0.20	0.08 to 0.12	1.10 to 1.30	Large piston rings small liners
No. 16..	various	various	(To customer's specifications)					Miscellaneous

TABLE II.—AGING CAST IRON TO RELIEVE CASTING STRESSES.

Reply	Temperature, deg. Fahr.	Time at Temperature, hours	Chemical Composition						
			Total Carbon, per cent	Manganese, per cent	Phosphorus, per cent	Sulfur, per cent	Silicon, per cent	Nickel, per cent	Chromium, per cent
No. 1...	800	4	3.50	0.55 to 0.75	0.20 max.	?	1.75 to 2.75	1.00	1.00
No. 2...	950 to 1100	1	3.25 to 3.42	0.45 to 0.75	0.17 to 0.30	0.075to0.10	1.85 to 2.25	....	....
No. 3...	975	varies			various				
No. 4...	1000	varies			various				
No. 5...	1000	3	3.00	0.60	0.20 max.	0.07	1.20	....	....
No. 6...	1050	3 to 5			various				
No. 7...	1200 to 1300[a]	4	3.50	0.55 to 0.75	0.20 max.	?	1.75 to 2.75	1.00	1.00
No. 8...	1350	3	3.00	0.60	0.20 max.	0.07	1.20	....	....
No. 9...	1400 to 1450[b]	1½	3.25 to 3.50	0.50 to 0.60	0.20 to 0.30	0.075to0.10	2.10 to 2.35	....	....
No. 10..	1500[b]	½	....	0.40 to 0.80	0.20 to 0.55	0.08 to 0.13	1.30 to 2.30	....	....
No. 11..	1540[b]	varies	3.55	0.54	0.58	0.078	2.42	....	....
No. 12..	1600 to 1800[c]	varies	3.40 to 3.70	0.50 to 0.70	0.40 to 0.80	0.05 to 0.08	1.60 to 2.00	....	....
No. 13..	varies		(To customer's specifications)						

[a] These treatments were really made with disregard to instructions issued.

[b] A combined softening and aging treatment.

[c] Necessary to relieve stresses and break down white structure due to casting in metal molds.

In Table II is given a summary of the data received referring to aging for relief of casting stresses (commonly termed strains).

Eight other replies stated that castings were aged for relieving stresses but no further data were submitted. Reply No. 2[1] also submitted the following data for the annealing treatment given:

	AS CAST	ANNEALED
Tensile strength, lb. per sq. in.	24 500	19 000
Elongation in 2 in., per cent	0.5	0.5
Transverse load, lb.	4 200	3 220
Deflection, in.	0.150	0.165
Brinell hardness number	195 to 200	160 to 170

This same manufacturer also furnished the data given in the following Table III on the effect of annealing on hardness of cast iron:

TABLE III.—EFFECT OF ANNEALING TEMPERATURE ON THE HARDNESS OF CAST IRON.

COMPOSITION: Total Carbon, 3.42 per cent; Graphitic Carbon, 2.95 per cent; Combined Carbon, 0.47 per cent; Manganese, 0.77 per cent; Phosphorus, 0.17 per cent; Sulfur, 0.092 per cent; Silicon, 1.87 per cent.

Specimen	Annealed 1 Hour at		Brinell Hardness Number		Scleroscope Hardness Number, Model D	Rockwell Hardness Number, "B" Scale, $\frac{1}{16}$-in. Ball, 100-kg. Load
	deg. Cent.	deg. Fahr	10-mm. Ball, 3000-kg. Load	5-mm. Ball, 750-kg. Load		
No. 1	as cast	as cast	201	206	37	93
No. 2	100	212	197	196	36	91
No. 3	200	392	201	206	37	93
No. 4	300	572	197	196	36	91
No. 5	400	752	197	196	36	90
No. 6	500	932	170	178	32	85
No. 7	600	1112	114	111	25	68
No. 8	700	1292	121	121	25	71
No. 9	800	1472	156	170	30	80
No. 10	900	1652	179	187	34	85
No. 11	1000	1832	179	187	34	85

NOTE.—$\frac{1}{8}$ in. of surface material removed after heat treatment before tests were made.

Five replies described the practice of quenching cast iron to increase hardness. One reply stated that some castings were quenched in water from 1650° F. to increase resistance to wear. Another stated that occasionally castings were quenched from 1600 to 1700° F. and tempered at 450° F. to produce a desired hardness. No other particulars were given. Still another stated that chilled rolls 36 in. in diameter with 24-in. face and a uniform wall thickness of 4 in. were quenched in a medium of the following composition:

Vitriol	$\frac{1}{2}$ lb.
Common salt	1 pk.
Saltpeter	$\frac{1}{2}$ lb.
Alum	2 lb.
Prussic potash	$\frac{1}{4}$ lb.
Cyanide of potash	$\frac{1}{4}$ lb.
Salt water	10 gal.

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[1] Furnished by Arrow Head Steel Products Co., Minneapolis, Minn., through the courtesy of Mr. O. E. Harder.

The composition of the solution had been found in an old catalogue of foundry equipment long since forgotten. The rolls were heated to a cherry red before quenching. For extreme hardness it was recommended to repeat the process a second or third time. It was stated that the results obtained were very good.

A manufacturer of shoe machinery submitted the following data regarding the hardening of iron castings for shoe levelers in order to resist wear:

QUENCHING TEMPERATURE, DEG. FAHR.	QUENCHING MEDIUM	SILICON CONTENT OF IRON, PER CENT	SIZE, IN.	BRINELL HARDNESS NUMBER
1500..........	water	1.60	1 by 1	did not harden
1650..........	water	1.60	1 by 1	440
1650..........	water	2.10	1 by 1	340
1700..........	water	2.10	2 by 4 by 10 3 by 5 by 10	did not harden

Several experiments were conducted to attempt to harden cams to reduce the rate of wear. The silicon content varied between 1.50 and 1.75 per cent and some castings contained up to 5.0 per cent of nickel. The Brinell hardness number as cast was 217 and the transverse breaking load was 2927 lb. No dimensions of the transverse test bar were given.

QUENCHING TEMPERATURE, DEG. FAHR.	QUENCHING MEDIUM	DRAWING TEMPERATURE, DEG. FAHR.	BRINELL HARDNESS NUMBER	TRANSVERSE LOAD, LB.	REMARKS
1650....	Air cooled	none	163	....	
1650....	Oil	none	340	....	
1650....	Oil	700	269	....	
1650....	Oil	800	336	3169	
1650....	Oil	none	430	....	cams weighing 8 to 9 lb.
1650....	Oil	600	418	....	
1650....	Oil	800	302	....	
1650....	Oil	900	286	....	

The following data were also submitted. The materials tested were 1-in. cubes of the stated composition:

	CHEMICAL COMPOSITION		BRINELL HARDNESS NUMBER				
				QUENCHED FROM CYANIDE CARBONATE BATH,			
SPECIMEN	SILICON, PER CENT	NICKEL, PER CENT	AS RECEIVED	AT 1600° F. IN WATER	AT 1600° F. IN OIL	AT 1550° F. IN OIL	AT 1550° F. IN WATER
No. 1.....	2.60	....	207	292	277	196	255
No. 2.....	2.00	....	179	388	341	255	363
No. 3.....	1.45	0.70	228	444	363	444	477
No. 4.....	1.48	1.70	241	514	477	477	444

Two replies stated that iron castings were subjected to carburizing and quenching treatments. The first stated that small parts for textile machinery were carburized in scrap leather and bone black and hardened by quenching in oil. The object was to increase resistance to wear. The second stated that latches and trips of surface grinders and automatic screw machines were given the following treatment: carburized in bone black for 4 hours at 1750° F., cooled in pots, reheated in lead to 1450° F., quenched in brine, and tempered at 430° F. The object was to increase resistance to wear and impact.

Digest of Literature on Heat Treatment of Cast Iron:

The sub-committee has made considerable progress in the preparation of a digest of all of the literature of heat treatment of cast iron published since 1908. It was not considered worth while to search the literature of earlier periods. To date about 375 abstracts have been prepared by the members of the sub-committee. This naturally entails a considerable amount of work. It was decided, after a general review of the abstracts, that more data from some of the original papers would be desirable to complete a really comprehensive digest. However, it will be possible to complete this digest and present it to the Society during the coming year. Following is a brief outline of the digest:

I. INTRODUCTION

1. Structure of normal cast iron.
2. Effect of alloying elements on the structure of normal cast iron.

II. EFFECT OF REGULATED COOLING FROM THE MELT ON THE STRUCTURE OF CAST IRON.

1. Retarded cooling—effect of mass and heated mold processes.
2. Accelerated cooling—chilled castings and permanent mold processes.

III. HEATING IN THE TEMPERATURE INTERVAL ROOM TEMPERATURE TO 800° F.—NO STRUCTURAL OR PHYSICAL CHANGE.

1. Dilatometry.
2. Electrical and magnetic properties.
3. Growth—graphitization by corrosion.
4. Aging—relief of casting stresses.
5. Baking—elimination of brittleness after pickling.
6. Low temperature malleablizing.

7. Rust proofing.
8. Coating with other metals—lead, tin, etc.

IV. Heating in the Temperature Interval 800° F. to the Critical Range—Structural Change, No Physical Change.

1. Nature of the structural change.
2. Effect of temperature on physical properties.
3. Growth.
4. Aging.
5. Low temperature malleablizing.
    - (*a*) Graphitization,
    - (*b*) Industrial processes.
6. Coating with other metals.
7. Preheating for welding.
8. Quenching.

V. Heating in the Temperature Interval Between the Critical Range and the Liquidus—Structural and Physical Change.

1. Nature of the physical change—effect of various elements.
2. Structural change—graphitization:
    - (*a*) graphitization during initial cooling from melt:
        - (*1*) Mechanism.
        - (*2*) Effect of various elements.
    - (*b*) graphitization during reheating above the critical range:
        - (*1*) Mechanism,
        - (*2*) Effect of various elements,
        - (*3*) Dilatometry,
        - (*2*) Growth,
        - (*5*) Annealing for softening,
        - (*6*) Heating in various gaseous atmospheres,
        - (*7*) High temperature malleablizing,
        - (*8*) Quenching and drawing,
        - (*9*) Carburizing,
        - (*10*) Coating with other metals,
        - (*11*) Oxidation and heat resistance,
        - (*12*) Welding.

Respectfully submitted by the sub-committee,

F. B. Coyle,
Chairman.

REPORT OF SECTIONAL COMMITTEE
ON
SPECIFICATIONS FOR CAST-IRON PIPE

The Sectional Committee on Cast-Iron Pipe was organized under the procedure of the American Standards Association (formerly the American Engineering Standards Committee) under the joint sponsorship of the American Gas Association, the American Water Works Association, the New England Water Works Association and the American Society for Testing Materials. The scope of the committee includes a unification of specifications for cast-iron pipe, elimination of unnecessary sizes and varieties, consideration of a scheme of metallic pipe and fittings applicable to all common mediums, and methods of making up joints. New standards for cast-iron pipe and special castings are being developed, the work having been assigned to three technical committees as follows:

- Technical Committee I on Dimensions, W. C. Hawley, chairman;
- Technical Committee II on Metallurgy, Processes and Tests, M. L. Enger, chairman;
- Technical Committee III on Corrosion and Protective Coating, L. P. Wood, chairman.

In view of the importance of the work of this sectional committee, the scope of the work assigned to each of these technical committees is presented together with a brief view of the work to date.

Work of Technical Committee I on Dimensions:

The work of this technical committee was organized under the following sub-committees:

- Sub-Committee I-A on Dimensions of Barrels of Sand-Cast Pipe, W. G. Hammerstrom, chairman;
- Sub-Committee I-B on Bell and Spigot Dimensions, Lugs and Harness, M. R. Sherrerd, chairman;
- Sub-Committee I-C on All Types of Pipe Except Vertical Sand Cast, F. H. Stephenson, chairman;
- Sub-Committee I-D on Fittings for All Types of Cast-Iron Pipe, C. Haydock, chairman.

To Technical Committee I has been assigned the work of reviewing schedules of dimensions and weights of pipe and fittings. It will seek to simplify these schedules by eliminating unnecessary sizes, weights and patterns. It will carry on such tests and investigations as may be required to determine moot questions such as proper thicknesses of barrels of pipe to resist static and water ram pressures, external pressures from earth and vehicular loads, stresses due to handling, to improper supports, to projecting ledge and frozen ground, etc. Consideration will be given to possible improvements in design of bells to resist stresses due to caulking, settlement, etc., and the design of lugs and harnesses. Various kinds of pipe cast in rotating molds, Universal, McWane, and other kinds of pipe not cast in vertical fixed sand molds will also be considered. Consideration will be given to fittings of all kinds, with a reduction in number and variety if possible, to strength of tees, crosses, Y-branches and sharp curves which because of their shape are subject to special stresses from hydraulic pressure.

Trench-load tests are being made at Iowa State College, under the direction of the technical committee, which will give definite information on some of the questions on earth loads on which there has been much discussion in the past. These include tests on the supporting strength of 8 and 20-in. pipe with and without internal pressures with different arrangements of bearings, both of single pieces and jointed pieces, which will give better knowledge of the stresses in the pipe when in the ground under normal earth loads, under heavy cover, and when the support under the pipe is for any reason poor. The quality of the metal in the pipe used in these trench-load tests is determined from records of tests of 2 by 1-in. bars cast from the heat; statement from the foundry making the pipe of the make-up of the charge, size of cupola, air pressure and quantity of air, and rate of melting; and from chemical analysis, if available, of metal from casting of similar thickness from the same heat.

Sub-Committee I-D is preparing two series of tests on fittings. The fittings are to be made from dimensions which are under consideration for adoption and which would give a new set of standards for fittings shorter in their laying lengths than the present standards of the American Water Works Association. They would be virtually of the same laying dimensions as the present American Society of Mechanical Engineers' flanged fittings for 125-lb. pressure. The first series of tests on these fittings would be to determine their bursting strength under water pressure, and the second series to determine friction loss through them at varying velocities and under a number of different conditions as to water leaving the fittings from their various outlets. In making both these series of tests, tests will be made at the same time on corresponding A.W.W.A. standard fittings.

Work of Technical Committee II on Metallurgy, Processes and Tests:

The work of this technical committee is organized under the following sub-committees:

Sub-Committee II-A on Raw Materials and Melting Practice, W. Flannery, chairman;
Sub-Committee II-B on Metallurgy and Chemistry, R. Moldenke, chairman;
Sub-Committee II-C on Physical Tests and Test Specimens, S. E. Killam, chairman;
Sub-Committee II-D on Experience, J. Goodman, chairman.

To Technical Committee II has been assigned the task of investigating pig iron and other raw materials entering into cast iron for pipe, and acceptance tests relating to the strength of the pipe and the quality of the metal in them. It will consider the injurious effects on the quality of cast iron caused by forced output from blast furnaces and some cupolas, the quality of some domestic and imported pig iron now on the market, and practical limits in the use of scrap of various kinds and quality of coke and limestone. All chemical analysis of metals for the sectional committee and technical committees will be made by this committee. It will consider the desirability of chemical specifications in general for composition of metal in the finished castings. It will assemble and analyze data on experience with pipe and failures by fracture in service with particular relation to evidence as to failures resulting from quality of iron or processes used.

Tests are under way at the University of Illinois on strength of pipe, using methods similar to those inaugurated by Professor Talbot, which have increased available knowledge of the properties of cast-iron pipe.

Work of Technical Committee III on Corrosion and Protective Coating:

The work of this technical committee has been organized under the following sub-committees:

Sub-Committee III-A on Corrosion of Cast-Iron Pipe, H. O. Forrest, chairman;
Sub-Committee III-B on Organic Coatings (Coal Tar, Asphalt, etc.), S. R. Church and E. C. Trowbridge, technical and executive chairmen, respectively;
Sub-Committee III-C on Inorganic Coatings (Cement Linings, etc.), J. E. Gibson, chairman;

Sub-Committee III-D on Water Corrosion Experience, E. E. Wall, chairman;
Sub-Committee III-E on Soil Corrosion Experience, J. R. Baylis, chairman;
Sub-Committee III-F on Hydraulics, M. L. Enger, chairman.

To Technical Committee III has been assigned the study of causes and mechanism of corrosion of cast-iron pipe exposed to soil or water, and of practical methods of reducing or eliminating such corrosion so far as this can be done at the pipe shop. Control of corrosion by treatment of soil or water, field coatings, metallic coatings, and corrosion due to stray-current electrolysis are outside the province of this committee. It will prepare specifications for the cement lining and coating of cast-iron pipe and fittings, including mortar and concrete and other inorganic linings and coatings, if any, excluding, however, purely metallic coatings; and specifications for the coating of cast-iron pipe and fittings at the pipe shop with organic materials. The committee will collect and digest the experience of pipe users with water corrosion of cast-iron pipe, soil corrosion not caused by stray current electrolysis, and correlate this experience with these two types of corrosion with the properties of the iron, the water or soil, and the coatings. It will study the territorial extent of soil corrosion troubles, the annual tonnage affected, the cost to the pipe user, and what he can afford to pay to avoid or minimize soil corrosion. Determinations will be made of the relative carrying capacities of cast-iron pipe with various coatings, both new and after exposure to active waters. The necessary over-size of pipes variously coated to give the same capacity at various ages in active waters as a corrosion-free and tuberculation-free pipe will be determined, and the money value of better coatings estimated.

Field or laboratory gagings, if found necessary or desirable, will be organized, and the committee will advise respecting any other hydraulic aspects of the corrosion and coating problem. Tests are in progress at the Massachusetts Institute of Technology on corrosion in water of cast-iron pipe of various chemical compositions, the specimens being kept immersed up to a maximum of 300 days, and the water being allowed to run without interruption past the specimens which are kept rotating. Knowledge gained from the loss in weight of the pipe from water corrosion and from its appearance and character of corrosion, taking into account the constituents of the metal and the nature of the water, will give valuable information in regard to both pipe and coating.

A great deal of the information to be collected by this sectional committee is being obtained by means of a questionnaire sent to over 600 superintendents of water and gas plants, and the 100 or more replies so far received show that much valuable information will be obtained, much of it of a nature never before collected and which will deserve very careful study and require much work on account of its volume. The data from these replies are being tabulated and summarized for the use of the committee.

Sub-Committee III-B has adopted a program for experimental work on organic coatings, principally tar, to be made at the new shops of the American Cast Iron Pipe Co. at Birmingham, Ala., under the general direction of S. R. Church, chairman of this sub-committee.

Sub-Committee III-C has adopted a program for work on tests in service of cement-lined pipes. These tests will be made in the system of the Birmingham Water Works Co., Birmingham, Ala., and the tests will cover a variety of conditions with mix of the mortar lining varying from the present rich mix of three parts of cement to one of sand down to as lean as one cement to two and a half of sand. Thickness of lining will vary from thin to ½-in. thick, and the tests will also cover different methods of curing and use of retempered mortar.

On all of these tests, the pipes come from foundries in different parts of the country and are not specimens picked for the tests but are the ordinary run of pipe, with the view that all tests should give information which will apply to average conditions. Complete information is recorded of all details of manufacture of each piece of pipe so that everything possible will be learned and published to connect cause and effect of all phenomena observed.

Published reports will be made of the information available from the tests, from the questionnaire and otherwise, without waiting for the issuance of a final report, so that all information obtained will be available to those interested as completely and as early as possible. Through the generous policy of the producers and certain of the users, over $60,000 has been made available for use in the research activities of the sectional committee.

Respectfully submitted on behalf of the sectional committee,

T. H. WIGGIN,
Chairman.

C. C. SIMPSON,
Secretary.

REPORT OF COMMITTEE A-5

ON

CORROSION OF IRON AND STEEL

The work of Committee A-5 during the year as reported upon by its sub-committees shows substantial progress in all of its projects.

The report of Sub-Committee III on Inspection, appended hereto, shows some additional failures at the Annapolis tests, the rate of corrosion continuing very much slower than observed at Fort Sheridan. Table I shows in detail the failures at Annapolis as the result of twelve years' atmospheric exposure. It will be noted that all of the failures are in the non-copper-bearing groups, two complete groups of light-gage sheets having entirely failed. The sub-committee is planning some extensive laboratory tests on sheets salvaged from the Fort Sheridan test racks, the work to include a study of rust formations, pitted surfaces, composition and structure of the remaining base metal, as compared with the original sheets.

The report of Sub-Committee V on Total Immersion Tests, appended hereto, shows some additional failures at Annapolis. The tests at Portsmouth, N. H., and Key West, Fla., where the specimens are immersed in sea water, are showing more rapid corrosion than was found in brackish water at Annapolis. At the end of two years about 30 per cent of the light-gage specimens have failed at Key West, and 14 per cent at Portsmouth. A novel means for recording the condition of corroded surfaces by means of wax impressions and electrotyping copper replicas in relief is being followed on the rivet heads in the plate tests at Key West.[1] This method will enable the sub-committee to compare the appearances of corroded surfaces from time to time and accurately estimate progressive corrosion.

Sub-Committee VI on Specifications for Zinc-Coated Products (F. F. Farnsworth, chairman) has prepared no new tentative specifications for zinc-coated products during the past year. The Tentative Specifications for Zinc-Coated (Galvanized) Barb Wire (A 121 - 28 T), and for Zinc-Coated (Galvanized) Steel Wire Strand (A 122 - 28 T) are still being studied and no further report can be made at this time. None of the existing tentative standards under the jurisdiction of the sub-committee are considered ready for advancement to standard.

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[1] Described in paper by E. S. Taylerson on "Method of Making Copper Replicas of Corroded Metal Objects," see *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. 234 (1929).

At a meeting held in Philadelphia on January 9, 1928, a small committee was appointed to draw up specifications for zinc-coated (galvanized) guy and messenger strand for telephone, telegraph and signal use. A draft of these specifications was presented for discussion at a meeting held in Atlantic City in June, 1928, and the sub-committee felt at that time that it did not seem desirable to prepare specifications for this class of material. The work on this problem accordingly has been dropped.

A group appointed to prepare specifications for zinc-coated wire rope highway guard and for chain-link highway guard, reported at a meeting in March, 1929, that apparently there was not sufficient demand for such specifications to justify their preparation. The work was accordingly dropped.

Plans for the reorganization of the work of the sub-committee for the purpose of preparing specifications for sherardized coatings are still tentative and little or no progress can be reported at this time. It is anticipated that new work for the coming year will include a study of the present requirements for metallic-coated products other than zinc coated, with a view to the preparation of specifications.

Sub-Committee VII on Methods of Testing (C. D. Hocker, chairman) is engaged in work largely of a research or fact finding nature. At the present time this work is confined to zinc-coated products.

During the year progress has been made in the study of accelerated corrosion testing methods. Four laboratories have constructed equipment for operating an accelerated weathering test. The test consists essentially of submitting samples to alternate exposure of water spray and of a simulated industrial atmosphere produced by charging ordinary air with a regulated amount of sulfur dioxide and carbon dioxide. Studies during the past year have been directed toward determining the conditions of operating the test. Experimental observations have been completed on the effects of temperature and on the effects of changing the concentration of corroding gases. Other conditions of the test to be investigated include frequencies of wetting and drying cycles, methods of cleaning samples between cycles, and effect of light.

When the conditions of operating this test are better worked out, its usefulness in judging resistance to corrosion will be checked by outdoor exposure tests. For this purpose samples are being held in reserve which are companion samples to those now being exposed by

Sub-Committee VIII on Field Tests of Metallic Coatings on its outdoor test racks.

Sub-Committee VIII on Field Tests of Metallic Coatings, as mentioned in its report appended hereto, has continued the inspection of the zinc-coated (galvanized) sheets at Brunot Island (Pittsburgh, Pa.) Altoona, Pa., State College, Pa., Sandy Hook, N. J. and Key West, Fla. Four of the ten No. 22 gage uncoated black sheets at Brunot Island and one each of the No. 22 gage uncoated black sheets at Altoona and Key West have failed. The coating on all of the No. 22 and No. 28 gage sheets with 0.75-oz. of zinc per sq. ft. have failed at the Altoona and Brunot Island locations, and coating failures are becoming prominent on the No. 22 gage sheets with 1.25 and 1.50 oz. of zinc per sq. ft. at the Altoona location. Corrosion at these two locations is quite pronounced in all weights of coatings, which indicates that light zinc coatings, 1.25 oz. or less, give fairly short protection for base metals in industrial atmospheres heavily laden with smoke gases and soot. The installation of the metallic-coated specimens of hardware, fastenings and structural shapes on the test racks has been completed, and one inspection of the samples at four of the five locations has been made. It is contemplated that the zinc-coated (galvanized) wire and wire fencing samples will be erected at all location within a few months, which will complete the present program of exposure tests.

Sub-Committee IX on Metal Culvert Tests (H. E. Smith, chairman) reports progress in the development of plans for conducting a comprehensive field test of culverts. Owing to the size and importance of the subject, very careful consideration is being given to determine what is the most desirable plan of work, and to avoid duplication of any well established and reliable research and conclusions of other investigators.

It was decided that the sub-committee should not only review the work of others but carry out a program of field tests of culverts so arranged as to give the greatest possible return in practical information.

A section has been appointed to study all available literature, as well as tests which have previously been made and those now in progress. Arrangements have recently been made through cooperation with the Highway Research Board to cover this field very completely. This same section will also devise methods of inspection and records as well as methods of rating the condition of the culverts which will be included in the committee's tests.

Another section has been appointed and is working on a program of tests which will include recommendations for the kinds and gages of the base metal, the weights of coating and the sizes of culverts to be tested, as well as a list of the desirable soil and water conditions.

As any system of such tests will require a considerable period of years, it is necessary to arrange them very carefully and only after mature consideration. It is expected that the committee will be in a position to put test culverts in the ground in the spring of 1930.

The data and statements of Committee A-5 are being used and will most likely continue to be used to an increasing extent for advertising purposes. In view of this situation the committee at its meeting on March 20, 1929, unanimously adopted a policy respecting the use of data and statements from its official reports for advertising purposes, in the following resolution:

> WHEREAS, Requests are often made to use the test data of Committee A-5 for advertising purposes, and in some instances misuse of these data has been made or is likely to result, be it
>
> RESOLVED, that Committee A-5 of the American Society for Testing Materials sanctions the use for advertising purposes of data or statements published in its copyrighted reports only under the following conditions:
>
> The data or statements quoted from the reports to the Society must relate to completed tests of completed committee work, and not to progress reports of incompleted tests or work.
>
> The data or statements quoted from the reports to the Society must be the complete information published in the report from which it is taken. If it is abstracted, the abstract shall be reviewed and approved by the Advisory Committee of Committee A-5, and shall be sufficiently complete that it will not state or imply conclusions other than those stated in the official reports to the Society.
>
> The data or statements quoted from the official reports must be clearly identified as such, and shall be set apart from any interpretation or comments on them that are made by the advertiser.

This report has been submitted to letter ballot of the committee, which consists of 96 members; 56 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

J. H. GIBBONEY,
Chairman.

JAMES ASTON,
Secretary.

REPORT OF SUB-COMMITTEE III ON INSPECTION OF THE ANNAPOLIS TESTS

Sub-Committee III on Inspection has held two meetings during the year, one at Chicago, Ill., on March 21, 1929, and the second at Annapolis, Md., on April 25, 1929, at which time the sheets at this location were inspected. Messrs. Gibboney, McDonnell, Passano, Smith, Taylerson and Thompson, representing the Bureau of Steam Engineering of the United States Navy Department, were present at the inspection; Messrs. Fleming and Wheaton being absent. The following additional failures were recorded:

Sheets S-1, 2, 9, 10 and 12 (No. 22 gage Low-Copper Pure Iron, Series B), manufactured by the American Rolling Mill Co., failed due to holes at the bottom of the sheets. These failures complete this entire group of sheets to fail at this location.

Sheet B-4 (No. 22 gage Copper-Bearing Open-hearth Steel, Series A) recorded as a failure in March, 1925, due to a broken upper left corner, has shown no appreciable progression of corrosion in this location in the past four years, which is reasonable grounds for considering that the small corner was broken off by mechanical damage, and suitable notation to this effect is made in Table I in this report.

No detailed record regarding texture, color and adherence of rust, or photographs of failures were made at this inspection due to inclement weather conditions; however, all mechanical damage not previously noted was recorded by the inspectors.

In March, 1929, Annapolis was visited by a very heavy wind storm which wrought considerable damage to racks 8 and 9. About one-half of rack 9 was blown over. One-third of rack 8 was lifted up and fell on the top edge of some of the sheets in rack 7. The sheets were carefully removed from the damaged racks and were transferred to rebuilt sections of racks 8 and 9.

The following covers a detailed examination of the sheets damaged in this wind storm:

SHEET	RACK 7
CCC-33.	Top left corner bent up about 2 in.
CCC-34.	Slightly scraped along top edge.
CCC-35.	Top left corner bent down about 3 in. Also dented at middle of top edge.
A-4.	Tip of upper left-hand corner bent down. Tip of upper right-hand corner bent down. Slightly scraped along top edge.

A-5.	Top left corner bent down about 3 in. Top right-corner bent down.
A-6.	Tip of upper left-hand corner bent up. Scraped along top edge.
A-8.	Top right corner badly bent. Sheet bent down along top stringer for entire width of sheet.
A-9.	Sheet bent down for its entire width along top stringer.
A-10.	Two small dents along top edge of sheet at upper right-hand corner.
A-11.	Two small dents along top edge of sheet at upper left-hand corner.

RACK 8

SHEET	
H-4.	Bent longitudinally along left-hand side of sheet (first and second corrugations).
H-5.	Left-hand side of sheet bent up in one spot at upper stringer. Also slightly damaged in lower right-hand corner.
H-6.	Sheet badly torn along lower edge.
H-7.	Sheet badly torn along lower edge.
H-8.	Slight scrape in middle of sheet.
H-9.	Damaged (bent and dented).
H-10.	Destroyed (sheet folded over longitudinally).
H-11.	Slightly scraped at lower right-hand corner (first corrugation).
H-12.	Slight dent near lower right-hand corner first corrugation, and also at bottom stringer on right-hand side.
H-13.	Sheet bent in lower left-hand corner and upper left-hand corner. Dent in middle of sheet along bottom edge.
H-16.	Dented from underneath near upper stringer.
I-6.	Tip of lower right-hand corner bent up.
I-7.	Slight dent in middle of lower edge.
I-9.	Upper right corner of sheet bent upward.

RACK 9

SHEET	
S4, 5, 6, 7, 8.	Destroyed, but sheets had previously been reported as failed prior to damage.
S-9.	Not bent. Failed at the April, 1929, inspection.
S-10.	Large hole punched through sheet by piece of timber. Failed at the April, 1929, inspection.
S 11, 13, 14.	Not bent. Failed prior to damage.
S-12.	Not bent. Failed at April, 1929, inspection.
T-4.	Upper right-hand corner bent down.
T-5.	Lower right-hand side of sheet near lower stringer bent up.
T-6.	Three dents in middle of sheet between stringers. One dent near lower left-hand corner.
T-7.	Upper right-hand side bent down.
T-8.	Tip of upper right-hand corner bent up. Tip of lower right-hand corner bent down.
T-9.	About 1½ in. of upper right-hand corner turned up. Slightly bent at lower right-hand corner.
T-10.	Upper right-hand corner bent up. Slightly bent on fourth corrugation at lower left-hand corner.
T-11.	Upper left-hand corner bent down badly. Also bent longitudinally entire length of sheet.

T-12.	Sheet bent down slightly in upper right-hand corner.
T-13.	Upper right-hand corner slightly bent.
T-14.	Badly bent in upper left-hand corner.
U-4.	Not bent. Apparently undamaged.
U-5.	Upper right-hand corner badly bent.
U-6.	Destroyed. Sheet folded over and broken in half longitudinally.

Table I (Plate I) is presented as a continuation of the same general plan of grouping the sheets at Annapolis as regarding the presence of copper and recording the failures at all inspection periods. It will be observed that Sheet B-4, appearing as a failure at the March, 1925, inspection in previous tables through error, does not show in this table as a failure. All failures at Annapolis are in the non-copper-bearing metals.

At the close of twelve years' observation of the Annapolis atmospheric tests the sub-committee would direct attention to the fact that the failures at this location confirm the findings at the Pittsburgh and Fort Sheridan locations that uncoated copper-bearing metal shows superiority in rust resisting properties as compared to uncoated non-copper-bearing metal of substantially the same general composition under atmospheric exposure.

This report was considered by the sub-committee at its meeting at Annapolis on April 25, 1929, and was unanimously approved.

Respectfully submitted on behalf of the sub-committee,

J. H. GIBBONEY,
Chairman.

TABLE I.—FAILURES AT ANNAPOLIS TESTS. INSPECTIONS OF 1917, 1918, 1919, 1920, 1921, 1922, 1

COMPARING COPPER-BEARING WITH NO

Group	Designation	Series	Description	Average Analysis, per cent						Number of Sheets in Test		
				Carbon	Manganese	Phosphorus	Sulfur	Silicon	Copper		Mar. 5, 1923.[a] 77 Months	Oct. 1 84 M
											No. 16 GAGE S	
EE	Puddled Iron	A	Copper-Bearing	0.035	0.03	0.119	0.018	0.125	0.319	12	None	No
HH	Copper-Bearing Basic Open-hearth Steel	A	" "	0.074	0.373	0.011	0.026	0.004	0.237	16	None	No
II	Copper-Bearing Bessemer Steel	A	" "	0.059	0.371	0.095	0.066	0.006	0.247	16	None	No
KK	Copper-Bearing Acid Open-hearth Steel	A	" "	0.108	0.433	0.085	0.043	0.005	0.234	18	None	No
CCC	Copper-Bearing Pure Iron	A	" "	0.023	0.026	0.005	0.028	0.005	0.236	12	None	No
TT	Copper-Bearing Steel, Newport Rolling Mill Co	B	" "	0.080	0.313	0.009	0.020	0.006	0.223	14	None	No
UU	Copper-Bearing Pure Iron, Allegheny Steel Co	B	" "	0.018	0.066	0.008	0.028	0.005	0.239	14	None	No
VV	Copper-Bearing Pure Iron, Whitaker-Glessner Co	B	" "	0.018	0.046	0.007	0.019	0.004	0.299	14	None	No
ZZ	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.113	0.413	0.109	0.045	.....	0.167	2	None	No
ZZ	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.080	0.34	0.091	0.036	.....	0.293	3	None	No
ZZ	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.073	0.305	0.089	0.045	None	0.532	2	None	No
ZZ	Copper-Bearing Open-hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.074	0.39	0.069	0.072	.....	0.255	3	None	No
ZZ	Copper-Bearing Open-hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.077	0.363	0.057	0.080	0.002	0.652	2	None	No
ZZ	Copper-Bearing Open-hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.06	0.42	0.050	0.048	Trace	0.363	2	None	No
	Total	.....	.....	.....	.....	.....	.....	.....	.....	130	None	No
AA	Bessemer Steel	A	Non-Copper-Bearing	0.043	0.419	0.083	0.042	0.004	0.012	18	None	No
BB	Open-hearth Steel	A	" " "	0.056	0.349	0.022	0.048	0.037	0.113	17	None	No
CC	Copper-Bearing Pure Iron	A	" " "	0.019	0.029	0.004	0.032	0.003	0.067	12	None	No
DD	Low-Copper Pure Iron	A	" " "	0.019	0.028	0.004	0.027	0.004	0.028	19	None	No
OO	Low-Copper Open-hearth Steel	A	" " "	0.108	0.371	0.009	0.029	0.007	0.029	12	None	No
MM	Open-hearth Steel, Alan Wood Iron and Steel Co	B	" " "	0.017	0.414	0.010	0.029	0.007	0.057	14	None	No
SS	Low-Copper Pure Iron, American Rolling Mill Co	B	" " "	0.017	0.021	0.006	0.021	0.006	0.025	14	None	No
XX	Low-Copper Pure Iron, Inland Steel Co	B	" " "	0.021	0.062	0.008	0.030	0.005	0.028	14	None	No
YY	Low-Copper Wrought Iron, Youngstown Sheet and Tube Co	B	" " "	0.03	0.051	0.123	0.019	0.203	0.023	3	None	No
ZZ	Bessemer Steel, Youngstown Sheet and Tube Co	B	" " "	0.08	0.43	0.080	0.031	0.008	0.014	3	None	No
ZZ	Open-hearth Steel, Youngstown Sheet and Tube Co	B	" " "	0.047	0.389	0.040	0.027	0.007	0.033	3	None	No
	Total	.....	.....	.....	.....	.....	.....	.....	.....	129	None	No
											No. 22 GAGE SH	
B	Open-hearth Steel	A	Copper-Bearing	0.06	0.27	0.014	0.053	0.006	0.187	9	None	No
C	Copper-Bearing Pure Iron	A	" "	0.015	0.028	0.006	0.036	0.003	0.194	9	None	No
E	Puddled Iron	A	" "	0.033	0.034	0.114	0.021	0.134	0.283	11	None	No
H	Copper-Bearing Basic Open-hearth Steel	A	" "	0.069	0.387	0.016	0.027	0.004	0.244	16	None	No
I	Copper-Bearing Bessemer Steel	A	" "	0.041	0.365	0.097	0.068	0.008	0.252	16	None	No
K	Copper-Bearing Acid Open-hearth Steel	A	" "	0.107	0.447	0.091	0.046	0.004	0.237	16	None	No
M	Open-hearth Steel, Alan Wood Iron and Steel Co	B	" "	0.093	0.419	0.013	0.041	0.011	0.185	14	None	No
T	Copper-Bearing Steel, Newport Rolling Mill Co	B	" "	0.083	0.313	0.009	0.020	0.005	0.227	14	None	No
U	Copper-Bearing Pure Iron, Allegheny Steel Co	B	" "	0.017	0.074	0.008	0.037	0.005	0.260	14	None	No
V	Copper-Bearing Pure Iron, Whitaker-Glessner Co	B	" "	0.018	0.051	0.007	0.021	0.005	0.304	14	None	No
Z	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.058	0.37	0.093	0.043	0.009	0.269	3	None	No
Z	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.055	0.38	0.110	0.046	.....	0.527	3	None	No
Z	Copper-Bearing Open-hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.067	0.351	0.045	0.052	0.003	0.187	3	None	No
Z	Copper-Bearing Open-hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.065	0.35	0.050	0.059	0.003	0.264	3	None	No
Z	Copper-Bearing Open-hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.073	0.42	0.052	0.054	Trace	0.641	3	None	No
	Total	.....	.....	.....	.....	.....	.....	.....	.....	148	None	No
A	Bessemer Steel	A	Non-Copper-Bearing	0.038	0.386	0.089	0.040	0.007	0.014	14	None	No
B	Open-hearth Steel	A	" " "	0.09	0.38	0.017	0.062	0.036	0.084	3	None	No
C	Copper-Bearing Pure Iron	A	" " "	0.01	0.028	0.002	0.027	0.002	0.141	3	None	No
D	Low-Copper Pure Iron	A	" " "	0.02	0.026	0.004	0.022	0.002	0.024	7	None	No
O	Low-Copper Open-hearth Steel	A	" " "	0.121	0.536	0.008	0.030	0.249	0.020	12	None	1 (1
S	Low-Copper Pure Iron, American Rolling Mill Co	B	" " "	0.02	0.023	0.006	0.022	0.004	0.022	14	None	5 (1
X	Low-Copper Pure Iron, Inland Steel Co	B	" " "	0.021	0.055	0.007	0.031	0.004	0.027	14	None	No
Y	Low-Copper Wrought Iron, Youngstown Sheet and Tube Co	B	" " "	0.03	0.055	0.139	0.021	0.218	0.020	3	None	No
Z	Bessemer Steel, Youngstown Sheet and Tube Co	B	" " "	0.063	0.41	0.102	0.044	0.009	0.013	3	None	No
Z	Bessemer Steel, Youngstown Sheet and Tube Co	B	" " "	0.077	0.44	0.095	0.036	0.003	0.140	3	None	No
Z	Open-hearth Steel, Youngstown Sheet and Tube Co	B	" " "	0.032	0.32	0.063	0.042	.....	0.019	3	None	No
	Total	.....	.....	.....	.....	.....	.....	.....	.....	79	None	2

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[1] In preparing this table, sheets below 0.15 per cent copper have been considered as non-copper-bearing, and those above 0.15 per cent copper as copper-bearing.

[a] No failures were recorded at inspections made prior to March 5, 1923; the detail records are accordingly not given here.

[b] Sheet B-4 shows mechanical damage to upper left-hand corner. Previously recorded as failure through error.

PLATE I.
PROC. AM. SOC. TESTING MATS.
VOL. 29, PART I.
REPORT OF COMMITTEE A-5:
CORROSION TESTS.

922, 1923, 1924, 1925, 1926, 1927, 1928, and April, 1929. Sheets Exposed October 17, 1916.
th Non-Copper-Bearing Materials.[1]

Date of Inspection											Number of Sheets Failed in Test
Oct. 10, 1923. 84 Months	Apr. 18, 1924. 90 Months	Oct. 23, 1924. 96 Months	Mar. 27, 1925. 101 Months	Oct. 10, 1925. 108 Months	Mar. 29, 1926. 113 Months	Nov. 17, 1926. 121 Months	Mar. 21, 1927. 125 Months	Oct. 5, 1927. 132 Months	May 7, 1928. 139 Months	Apr. 25, 1929. 150 Months	
Gage Sheets											
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
age Sheets											
None	None	None	None[b]	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
1 (1)	None	None	None	3, 4, 5, 9 (4)	2 (1)	6, 11 (2)	None	7, 10 (2)	None	None	10
5 (1)	None	7 (1)	8 (1)	4 (1)	14 (1)	3 (1)	None	13 (1)	6, 11 (2)	1, 2, 9,10, 12 (5)	14 (all)
None	None	None	None	None	None	None	4 (1)	None	None	None	1
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	1, 2, 3 (3)	....	3 (all)
None	None	None	None	None	None	None	None	None	None	None	None
None	None	None	None	None	None	None	None	None	None	None	None
2	None	1	1	5	2		1		5	5	28

TABLE I.—REPORT ON SUBMERGED TESTS. SHEETS EXPOSED JUNE 2, 1920, IN RUNNING SE

NO. 16 GAGE

Group	Designation	Series	Description	Average Analysis, per cent						Number of Sheets in Test	Aug. 6, 1925, 1890 Days	Sept. 9, 1925, 1924 Days	Oct. 22, 1925, 1967 Days	Nov. 24, 1925, 2000 Days	Feb. 19, 1926, 2087 Days	Mar. 25, 1926, 2121 Days
				Carbon	Manganese	Phosphorus	Sulfur	Silicon	Copper							
AA	Bessemer Steel	A	Non-Copper-Bearing	0.036	0.428	0.084	0.042		0.011	6		1, 10				
ZZ	Bessemer Steel, Youngstown Sheet and Tube Co	B	" " "	0.080	0.427	0.081	0.031	0.008	0.014	6	4	1			2	
II	Copper-Bearing Bessemer Steel	A	Copper-Bearing	0.062	0.353	0.093	0.065	0.006	0.255	6		1, 10				
ZZ1	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.112	0.412	0.109	0.045		0.167	6	103, 102, 102	102				
ZZ2	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.076	0.340	0.088	0.034		0.291	6	202	201				
ZZ3	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.072	0.305	0.089	0.045		0.532	6		307				
OO	Basic Open-Hearth Steel	A	Non-Copper-Bearing	0.109	0.358	0.011	0.029		0.025	6	1, 3, 4, 6	7, 8				
MM	Basic Open-Hearth Steel, Alan Wood Iron and Steel Co	B	" " "	0.110	0.420	0.008	0.027	0.010	0.063	6	2, 7, 15				5	
ZZ4	Basic Open-Hearth Steel, Youngstown Sheet and Tube Co	B	" " "	0.060	0.390	0.040	0.024		0.033	6	417, 418, 418, 418			417		
BB	Basic Open-Hearth Steel	A	" " "	0.046	0.296	0.025	0.058		0.138	6	3, 6, 9, 15					
HH	Copper-Bearing Basic Open-Hearth Steel	A	Copper-Bearing	0.083	0.369	0.011	0.026	0.002	0.252	6	2, 5, 12					
TT	Copper-Bearing Basic Open-Hearth Steel, Newport Rolling Mill Co	B	" "	0.087	0.338	0.008	0.019		0.221	6	1, 6, 8, 9					
ZZ5	Copper-Bearing Basic Open-Hearth Steel, Youngstown Sheet and Tube Co.	B	" "	0.078	0.390	0.071	0.075		0.256	6	503	501				503, 503
ZZ6	Copper-Bearing Basic Open-Hearth Steel, Youngstown Sheet and Tube Co.	B	" "	0.079	0.359	0.055	0.080		0.651	6						
ZZ7	Copper-Bearing Basic Open-Hearth Steel, Youngstown Sheet and Tube Co.	B	" "	0.060	0.420	0.050	0.048		0.363	6						
CC	Low-Copper Pure Iron	A	Non-Copper-Bearing	0.022	0.031	0.005	0.031	0.003	0.086	6	7	3			5	
DD	Low-Copper Pure Iron	A	" " "	0.020	0.027	0.004	0.028	0.002	0.027	6	11, 15, 16	12, 13				
SS	Pure Iron, American Rolling Mill Co	B	" " "	0.022	0.032	0.005	0.018	0.007	0.027	6	3, 9, 17					6, 12
XX	Pure Iron, Inland Steel Co	B	" " "	0.028	0.079	0.009	0.029		0.034	6	3, 5, 7, 32, 35	2				
CCC	Copper-Bearing Pure Iron	A	Copper-Bearing	0.022	0.027	0.005	0.028	0.006	0.251	6	3, 4, 12, 15					
UU	Copper-Bearing Pure Iron, Allegheny Steel Co	B	" "	0.028	0.071	0.006	0.031	0.006	0.247	6	4, 6, 7, 8		1			
VV	Copper-Bearing Pure Iron, Whitaker-Glessner Co	B	" "	0.024	0.051	0.006	0.017		0.308	6	1, 19, 30, 31, 32					
KK	Copper-Bearing Acid Open-Hearth Steel	A	Copper-Bearing	0.098	0.453	0.085	0.041		0.220	6	9, 12, 16	6				
YY	Low-Copper Puddled Iron, Youngstown Sheet and Tube Co	B	Non-Copper-Bearing	0.030	0.050	0.127	0.018	0.197	0.024	6	8, 8, 8, 8	9				9
EE	Copper-Bearing Puddled Iron	A	Copper-Bearing	0.045	0.026	0.114	0.019	0.117	0.300	6						
										150	60	17	1	1	3	5
	Total Failures to Date											77	78	79	82	87

PLATE II.
PROC. AM. SOC. TESTING MATS.
VOL. 29, PART I.
REPORT OF COMMITTEE A-5:
TOTAL IMMERSION TESTS.

G SEVERN RIVER WATER AT THE NAVAL ENGINEERING EXPERIMENT STATION, ANNAPOLIS, MD.

6 GAGE SHEETS

Mar. 25, 1926, 2121 Days	Apr. 24, 1926, 2151 Days	May 24, 1926, 2181 Days	June 24, 1926, 2212 Days	July 28, 1926, 2246 Days	Aug. 27, 1926, 2276 Days	Sept. 28, 1926, 2308 Days	Nov. 4, 1926, 2345 Days	Dec. 4, 1926, 2378 Days	Jan. 12, 1927, 2414 Days	Feb. 12, 1927, 2445 Days	May 6, 1927, 2528 Days	June 16, 1927, 2569 Days	July 19, 1927, 2602 Days	Sept. 29, 1927, 2674 Days	Dec. 5, 1927, 2741 Days	Jan. 7, 1928, 2774 Days	Feb. 11, 1928, 2809 Days	May 1, 1928, 2889 Days	June 19, 1928, 2938 Days	July 19, 1928, 2968 Days	Oct. 19, 1928, 3059 Days	Nov. 19, 1928, 3090 Days	
				2							1	4	13			4		7					
	202			103	103 306		9	204		307	201 306	15 306			307					18	201		
	1													417		11							
03, 503	16	12			3				501		1, 4 710, 711	602			710		710	605	610		711	602	
6, 12	8 21			1			10				14												
	21		8	3		13																	
	3						7																
9																							
	9												4		2			6					
5	8	1	1	4	3	1	3	1	1	1	8	4	2	1	3	2	1	3	1	1	2	1	
87	95	96	97	101	104	105	108	109	110	111	119	123	125	126	129	131	132	135	136	137	139	140	

TABLE II.—REPORT ON SUBMERGED TESTS. SHEETS EXPOSED MARCH

No. 22 GAGE

Group	Designation	Series	Description	Average Analysis, p			
				Carbon	Manganese	Phosphorus	Sulfur
A	Bessemer Steel	A	Non-Copper-Bearing	0.038	0.380	0.090	0.036
Z	Bessemer Steel, Youngstown Sheet and Tube Co	B	" " "	0.062	0.405	0.100	0.043
Z1	Bessemer Steel, Youngstown Sheet and Tube Co	B	" " "	0.075	0.448	0.092	0.035
I	Copper-Bearing Bessemer Steel	A	Copper-Bearing	0.041	0.372	0.094	0.067
Z2	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.058	0.370	0.093	0.043
Z3	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co	B	" "	0.055	0.380	0.111	0.044
B	Open-Hearth Steel	A	Non-Copper-Bearing	0.023	0.229	0.012	0.052
F	Open-Hearth Steel	A	" " "	0.293	0.503	0.026	0.039
O	Low-Copper Open-Hearth Steel	A	" " "	0.118	0.522	0.009	0.029
Z4	Open-Hearth Steel, Youngstown Sheet and Tube Co	B	" " "	0.042	0.318	0.063	0.042
B	Open-Hearth Steel	A	Copper-Bearing	0.038	0.232	0.009	0.063
G	Open-Hearth Steel	A	" "	0.290	0.510	0.027	0.039
H	Copper-Bearing Basic Open-Hearth Steel	A	" "	0.076	0.371	0.011	0.028
M	Open-Hearth Steel, Alan Wood Iron and Steel Co	B	" "	0.097	0.396	0.014	0.043
T	Copper-Bearing Steel, Newport Rolling Mill Co	B	" "	0.078	0.322	0.010	0.020
Z5	Copper-Bearing Open-Hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.067	0.351	0.045	0.052
Z6	Copper-Bearing Open-Hearth Steel, Youngstown Sheet and Tube Co	B	" "	0.062	0.388	0.054	0.053
D	Low-Copper Pure Iron	A	Non-Copper-Bearing	0.012	0.027	0.003	0.022
S	Low-Copper Pure Iron, American Rolling Mill Co	B	" " "	0.009	0.016	0.007	0.020
X	Low-Copper Pure Iron, Inland Steel Co	B	" " "	0.010	0.065	0.007	0.026
C	Copper-Bearing Pure Iron	A	Copper-Bearing	0.025	0.034	0.006	0.039
U	Copper-Bearing Pure Iron, Allegheny Steel Co	B	" "	0.016	0.075	0.009	0.034
V	Copper-Bearing Pure Iron, Whitaker-Glessner Co	B	" "	0.012	0.048	0.008	0.020
K	Copper-Bearing Acid Open-Hearth Steel	A	" "	0.112	0.438	0.090	0.044
E	Puddled Iron	A	Copper-Bearing	0.039	0.032	0.114	0.021
Y	Low-Copper Wrought Iron, Youngstown Sheet and Tube Co	B	Non-Copper-Bearing	0.030	0.052	0.146	0.021
	Total Failures to Date						

PLATE III.
PROC. AM. SOC. TESTING MATS.
VOL. 29, PART I.
REPORT OF COMMITTEE A-5:
TOTAL IMMERSION TESTS.

ARCH 1, 1927, IN SEA WATER AT U. S. NAVAL STATION, KEY WEST, FLA.

22 GAGE SHEETS

alysis, per cent			Number of Sheets in Test	Failures on Date of Inspections										
Sulfur	Silicon	Copper		Mar. 16, 1928, 381 Days	Apr. 30, 1928, 427 Days	June 4, 1928, 462 Days	July 5, 1928, 493 Days	Sept. 7, 1928, 557 Days	Oct. 8, 1928, 588 Days	Nov. 7, 1928, 618 Days	Dec. 6, 1928, 647 Days	Jan. 7, 1929, 679 Days	Jan. 21, 1929, 693 Days	Mar. 7, 1929, 738 Days
0.036		0.017	6		5					2				
0.043		0.014	6			1			2			1	1	
0.035		0.140	6			102		101			101		101, 102, 108	
0.067	0.010	0.254	6			6, 21, 23						30		
0.043		0.266	6										204	
0.044		0.522	6										301	
0.052	0.004	0.117	3										15	
0.039	0.010	0.038	6			10						10		
0.029	0.223	0.021	6	15, 17		16							9, 28	
0.042		0.019	6	418		417, 418, 421								
0.063	0.004	0.167	3											
0.039	0.010	0.241	6				10							
0.028	0.002	0.246	6			11							8	
0.043	0.012	0.184	6					9						
0.020		0.237	6			2								
0.052		0.187	6										501	
0.053		0.275	6			604								
0.022	0.002	0.021	6											13
0.020	0.008	0.022	6											
0.026		0.033	6	3						1				
0.039	0.020	0.198	6										12	
0.034	0.003	0.269	6											
0.020		0.299	6							6				
0.044	0.002	0.231	6	3	6								27	
0.021	0.110	0.241	6							4				
0.021	0.213	0.019	6	5		3		1			4		2	
			150	6	2	14	1	3	1	4	2	3	14	1
....	....	....	....	....	8	22	23	26	27	31	33	36	50	51

REPORT OF SUB-COMMITTEE V ON TOTAL IMMERSION TESTS

Annapolis Immersion Tests:

Table I (Plate II) gives a detailed record of 140 failures out of 150 No. 16 gage specimens in the test in running Severn River water at the Naval Engineering Experiment Station, Annapolis, Md., up to February, 1929. No additional failures have occurred, however, since the November, 1928, inspection. Inspections were made every month during the past year but the dates of individual inspection are not recorded in the table unless failures were found.

Sea Water Immersion Tests:

The No. 22 gage sheets exposed March 1, 1927, in sea water at Key West Navy Yard showed a total of 51 failures out of 150 up to March, 1929. A detailed record of failures is given in Table II (Plate III). At Portsmouth, N. H., where the No. 22 gage sheets were exposed in sea water March 7, 1927, 20 failures out of 150 were recorded up to March, 1929, as shown in Table III. None of the No. 16 gage sheets have failed so far at either place.

At the January inspection at Key West all of the No. 22 gage specimens were sand-blasted according to instructions. The sand-blasting is to be repeated every six months on all these specimens.

The riveted plate and copper-bearing pipe immersed in sea water at Key West, Fla., and Portsmouth, N. H., have been inspected regularly. The inspections of riveted plates at Port Arthur, Tex., have also been reported. So far it seems inadvisable to draw any conclusions from either the riveted plate or the pipe tests, as corrosion has not gone far enough.

In the case of the riveted plates the measurement of the heights of the points or heads of rivets does not seem to be giving a satisfactory record of the corrosion taking place, and is lacking in precision. The changes in height found up to the present time, however, are very slight. One difficulty which may become more serious as time goes on is the lack of a fixed plane to which these measurements can be referred.

Last year an attempt was made to reproduce the actual condition of the corroded surface by means of a plaster cast and this gave a promising method of record. At the January inspection this scheme was carried out in another way by Mr. E. S. Taylerson, a member of the committee, by taking a wax impression and electrotyping a

TABLE III.—REPORT ON SUBMERGED TESTS. SHEETS EXPOSED MARCH 7, 1927, IN SEA WATER AT U. S. NAVY YARD, PORTSMOUTH, N. H.

No. 22 GAGE SHEETS

Group	Designation	Series	Description	Average Analysis, per cent						Number of Sheets in Test	Failures on Date of Inspections				
				Carbon	Manganese	Phosphorus	Sulfur	Silicon	Copper		Apr. 9, 1928, 399 Days	May 8, 1928, 428 Days	June 13, 1928, 464 Days	Jan. 4, 1929, 669 Days	Mar. 4, 1929, 728 Days
A	Bessemer Steel	A	Non-Copper-Bearing	0.038	0.380	0.094	0.042	0.007	0.012	6					
Z	Bessemer Steel, Youngstown Sheet and Tube Co.	B	" " "	0.061	0.400	0.114	0.048		0.012	6					
Z1	Bessemer Steel, Youngstown Sheet and Tube Co.	B	" " "	0.071	0.393	0.089	0.045	0.009	0.135	6					
I	Copper-Bearing Bessemer Steel	A	Copper-Bearing	0.041	0.382	0.098	0.068		0.250	6					
Z2	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co.	B	" "	0.050	0.380	0.089	0.037	0.005	0.259	6					
Z3	Copper-Bearing Bessemer Steel, Youngstown Sheet and Tube Co.	B	" "	0.041	0.365	0.095	0.045		0.518	6					
B	Open-Hearth Steel	A	Non-Copper-Bearing	0.110	0.380	0.016	0.065	0.013	0.082	4					
F	Open-Hearth Steel	A	" " "	0.293	0.503	0.026	0.039	0.010	0.038	6				11	
O	Low-Copper Open-Hearth Steel	A	" " "	0.142	0.545	0.007	0.027	0.217	0.015	6	30			33, 34	
Z4	Open-Hearth Steel, Youngstown Sheet and Tube Co.	B	" " "	0.100	0.319	0.069	0.044		0.018	6					
B	Open-Hearth Steel	A	Copper-Bearing	0.090	0.210	0.009	0.060	0.004	0.190	2					
G	Open-Hearth Steel	A	" "	0.290	0.510	0.027	0.039	0.010	0.241	6			10, 11		12
H	Copper-Bearing Basic Open-Hearth Steel	A	" "	0.063	0.403	0.017	0.027	0.005	0.245	6	32	38	26	35	
M	Open-Hearth Steel, Alan Wood Iron and Steel Co.	B	" "	0.090	0.400	0.011	0.039		0.187	6			22	29, 35	38
T	Copper-Bearing Steel, Newport Rolling Mill Co.	B	" "	0.082	0.309	0.009	0.022		0.214	6				39	
Z5	Copper-Bearing Open-Hearth Steel, Youngstown Sheet and Tube Co.	B	" "	0.060	0.360	0.047	0.056		0.198	6					
Z6	Copper-Bearing Open-Hearth Steel, Youngstown Sheet and Tube Co.	B	" "	0.075	0.390	0.053	0.053	trace	0.261	6					608
D	Low-Copper Pure Iron	A	Non-Copper-Bearing	0.033	0.025	0.004	0.020		0.025	6			33		
S	Low-Copper Pure Iron, American Rolling Mill Co.	B	" " "	0.016	0.020	0.006	0.023		0.018	6				19	
X	Low-Copper Pure Iron, Inland Steel Co.	B	" " "	0.016	0.054	0.006	0.032		0.025	6					
C	Copper-Bearing Pure Iron	A	Copper-Bearing	0.032	0.025	0.005	0.030	0.006	0.178	6				32	
U	Copper-Bearing Pure Iron, Allegheny Steel Co.	B	" "	0.012	0.066	0.008	0.039		0.258	6					
V	Copper-Bearing Pure Iron, Whitaker-Glessner Co.	B	" "	0.017	0.048	0.006	0.021		0.302	6					
K	Copper-Bearing Acid Open-Hearth Steel	A	" "	0.102	0.455	0.087	0.045		0.238	6					
E	Puddled Iron	A	Copper-Bearing	0.024	0.034	0.111	0.022	0.146	0.297	6					
Y	Low-Copper Wrought Iron, Youngstown Sheet and Tube Co.	B	Non-Copper-Bearing	0.030	0.058	0.154	0.020	0.223	0.021	6					
										150	2	1	5	9	3
	Total Failures to Date											3	8	17	20

replica of the surface. This method of recording is described in a paper by Mr. Taylerson entitled, "Method of Making Copper Replicas of Corroded Metal Objects," being presented at this annual meeting of the Society.[1]

The sub-committee also recommends that a practical test of various kinds of iron and steel rivets be made in a ship bottom. Mr. James French of Lloyd's Register of Shipping was appointed chairman of a special section to report ways and means of carrying out such a test.

This report was considered by the sub-committee at its meeting at Chicago on March 19, 1929, and was unanimously approved.

Respectfully submitted on behalf of the sub-committee,

F. N. SPELLER,
Chairman.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. 234 (1929).

REPORT OF SUB-COMMITTEE VIII ON FIELD TESTS OF METALLIC COATINGS

The activities of Sub-Committee VIII during the past year are set forth below under the several materials now being studied.

GALVANIZED SHEET

A Special Committee on Inspection of Galvanized Sheet has been functioning under the chairmanship of M. E. McDonnell and has made several inspections during the year as indicated below.

The rack at Altoona was inspected on July 27, 1928, by Messrs. Badger (representing G. A. Reinhardt), McDonnell, Passano, Smith, Taylerson and Weidman; on October 30, 1928, by Messrs. Badger (representing G. A. Reinhardt), Harnden (representing F. A. Hull), Hocker, McDonnell, Passano, Rawdon, Smith, Taylerson and Trewin; and on January 28, 1929, by Messrs. Moody (representing M. E. McDonnell), Passano, Reinhard (representing C. S. Trewin), and Taylerson.

The rack at Brunot Island was inspected on July 26, 1928, by Messrs. Badger (representing G. A. Reinhardt), McDonnell, Passano, Smith, Taylerson and Weidman; on October 29, 1928, by Messrs. Badger (representing G. A. Reinhardt), Harnden (representing F. A. Hull), Hocker, McDonnell, Passano, Rawdon, Taylerson and Trewin; and on January 29, 1929, by Messrs. Moody (representing M. E. McDonnell), Passano, Reinhard (representing C. S. Trewin), and Taylerson.

The rack at Sandy Hook was inspected on October 31, 1928, by Messrs. Finkeldey (representing Singmaster & Breyer) (visitor), Harnden (representing F. A. Hull), Hocker, Giblin (representing Diamond Expansion Bolt Co.) (visitor), McDonnell, Passano, Pleister (representing Diamond Expansion Bolt Co.) (visitor), Rawdon, Smith, Taylerson and Trewin.

The rack at Key West was inspected on January 21, 1929, by Messrs. McDonnell, Passano and Taylerson.

The rack at State College was inspected on October 20, 1928, by Messrs. Finkeldey (representing Singmaster & Breyer) (visitor), Harnden (representing F. A. Hull), Hocker, McDonnell, Passano, Rawdon, Smith, Taylerson and Trewin.

Previous reports of the sub-committee discuss in a general way the order in which color changes occur on hot-dipped galvanized coatings when exposed to the atmosphere. These may be briefly reviewed as follows: Corrosion products of zinc are followed by gray color, generally attributed to the corrosion of iron-zinc alloys. On further exposure, mixed corrosion products of iron and zinc form a yellow discoloration. This may be followed by further modification of color until an oxide of the base metal is observed which point was chosen as indicating failure of the coating.

Table I.—Record of Coating Failures on Altoona Rack Sheets Exposed April 22, 1926.

Description	Total Number of Samples	Apr. 7, 1927 0.96 Year	Sept. 28, 1927 1.43 Years	May 1, 1928 2.03 Years	July 27, 1928 2.27 Years	Oct. 30, 1928 2.53 Years	Jan. 28, 1929 2.77 Years	Total Number of Failures	Average Life in Years
No. 16 Gage, 2.50 oz. per sq. ft.	10	None	None	None	None	None	None	None	....
No. 22 Gage, 2.50 oz. per sq. ft.	18	None	None	None	None	None	None	None	....
No. 22 Gage, 2.00 oz. per sq. ft.	18	None	None	None	None	None	None	None	....
No. 22 Gage, 1.50 oz. per sq. ft.	18	None	None	None	2	4	None	6	....
No. 22 Gage, 1.25 oz. per sq. ft.	18	None	None	None	13	3	None	16	(2.4)[a]
No. 22 Gage, 0.75 oz. per sq. ft.	14	None	6	1	7	..	..	14	1.9
No. 28 Gage, 0.75 oz. per sq. ft.	10	None	1	3	6	..	..	10	2.1
Total	106	None	7	4	28	7	None	46	

[a] Figures shown in parentheses are not to be considered as final.

Table II.—Record of Coating Failures on Brunot Island Rack. Sheets Exposed April 21, 1926.

Description	Total Number of Samples	Apr. 6, 1927 0.96 Year	Sept. 27, 1927 1.43 Years	Apr. 30, 1928 2.03 Years	July 26, 1928 2.27 Years	Oct. 29, 1928 2.53 Years	Jan. 29, 1929 2.78 Years	Total Number of Failures	Average Life in Years
No. 16 Gage, 2.50 oz. per sq. ft.	12	None	None	None	None	None	None	None	...
No. 22 Gage, 2.50 oz. per sq. ft.	18	None	None	None	None	None	None	None	...
No. 22 Gage, 2.00 oz. per sq. ft.	18	None	None	None	None	None	None	None	...
No. 22 Gage, 1.50 oz. per sq. ft.	18	None	None	None	None	None	None	None	...
No. 22 Gage, 1.25 oz. per sq. ft.	18	None	None	None	None	2	None	2	...
No. 22 Gage, 0.75 oz. per sq. ft.	14	None	None	5	9	..	..	14	2.2
No. 28 Gage, 0.75 oz. per sq. ft.	10	None	None	2	8	..	..	10	2.2
Total	108	None	None	7	17	2	None	26	

The observations which have been made on the material exposed at the various locations show the outstanding influence of the atmospheric conditions on the appearance of corrosion products and on the life of coating. Until time and investigation show the significance of the observations which have been made, the report can only be one of progress.

The sheets on the racks are divided into groups according to nominal weights of coating. The weight of coating on a single sheet may vary from the nominal weight group in which it is placed. In those groups at Altoona where coating failures have developed it was observed that some sheets in two or more groups failed at the same time.

Considering the small number of sheets of a single kind in each group it is thought inadvisable at the present time to attempt to distinguish between individuals. For this reason, and to indicate the progress of the test, an average life of coating for each group has been given where a sufficient number of failures have occurred.

Altoona and Brunot Island (Pittsburgh), Pa.:

The samples at these racks show more advanced corrosion than those at the other locations. (See Tables I and II.) The sheets at both places are discolored by a dark deposit of soot and cinders, which prevents estimation of exposed iron-zinc alloy.

After 2.75 years of exposure, yellow corrosion products were apparent on some sheets in all classes of coating, which discoloration was general on the lighter-coated sheets. Many of these show base metal rust, in addition. These descriptions are illustrated in Figs. 1, 2 and 3 (Plates IV, V and VI), showing all of the top samples at Altoona.

Due to the rapid corrosion rate at these locations, it was decided by the committee that these racks should be inspected four times a year.

Sandy Hook, N. J.:

At the Sandy Hook rack there has been less corrosion than at Altoona and Brunot Island. In every case the original zinc surface of the sheets is still present, although gray colors can be distinguished on some sheets in all classes and yellow corrosion products are now apparent on about one-half of the lightest-coated sheets.

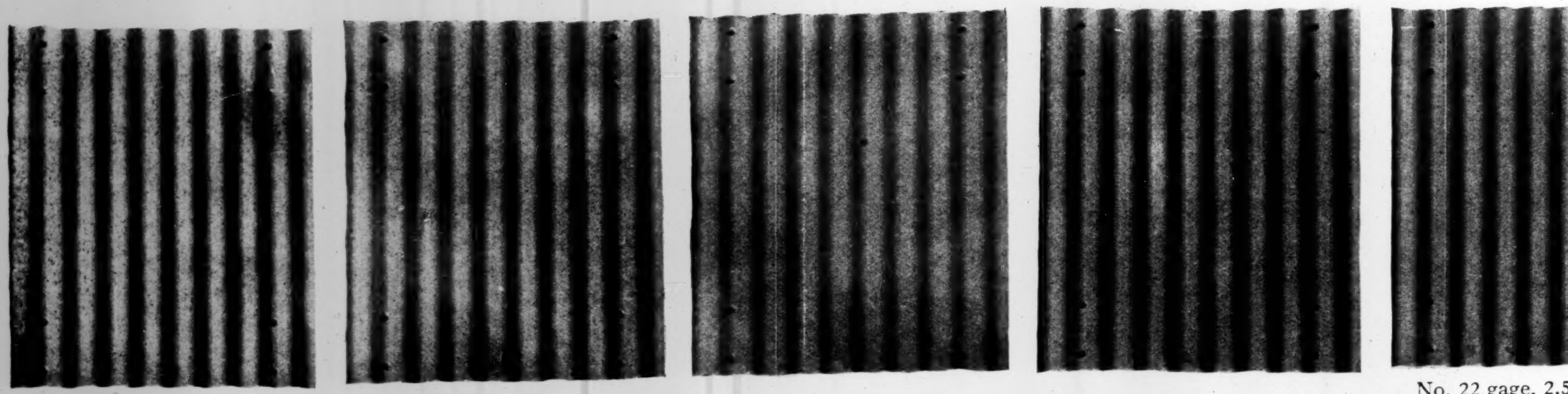
No base metal rust has yet been observed on any sample.

Key West, Fla.:

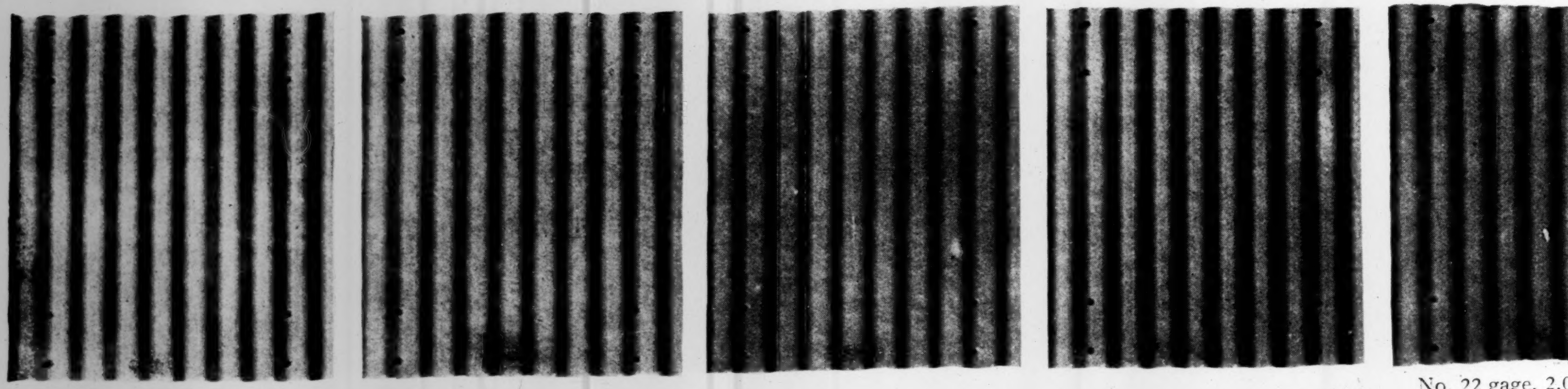
At the last inspection at Key West on January 21, 1929, white zinc salts had obscured, to a large extent, the appearances which were characteristic of the northern locations. The zinc compounds were not washed off by a heavy rain which fell during the previous evening.

State College, Pa.:

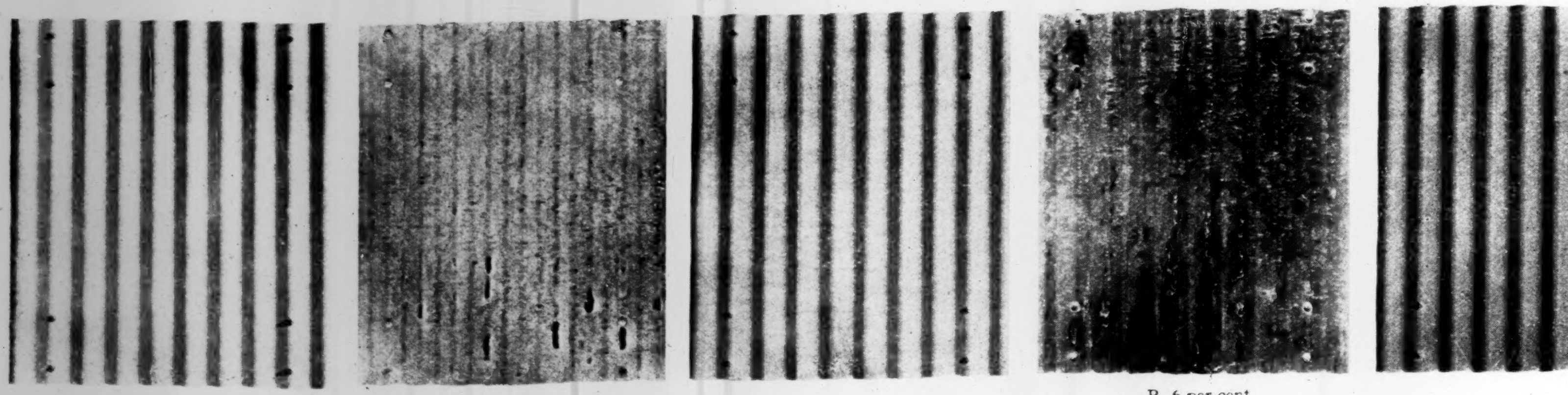
The corrosion at this location is slower than at other racks. The sheets are clean and the original spangles can be observed on all samples. Some chatter marks are visible in the lighter coatings.



No. 22 gage, 2.5



No. 22 gage, 2.



R, 3 per cent.

R, 6 per cent.

No. 22 gage, 1.

FIG. 1.—Altoona Test Rack,

R signifies bas

PLATE IV.
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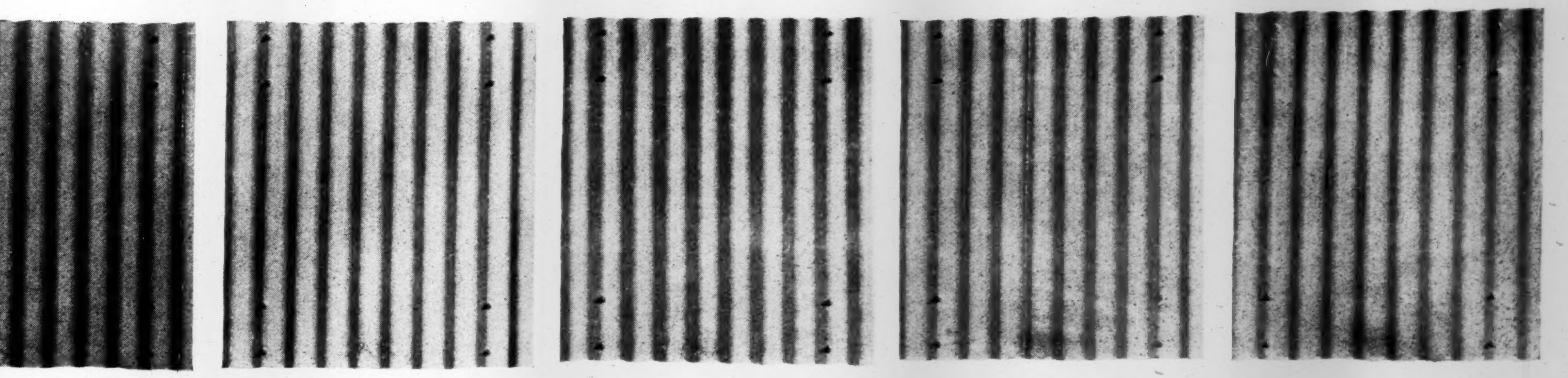
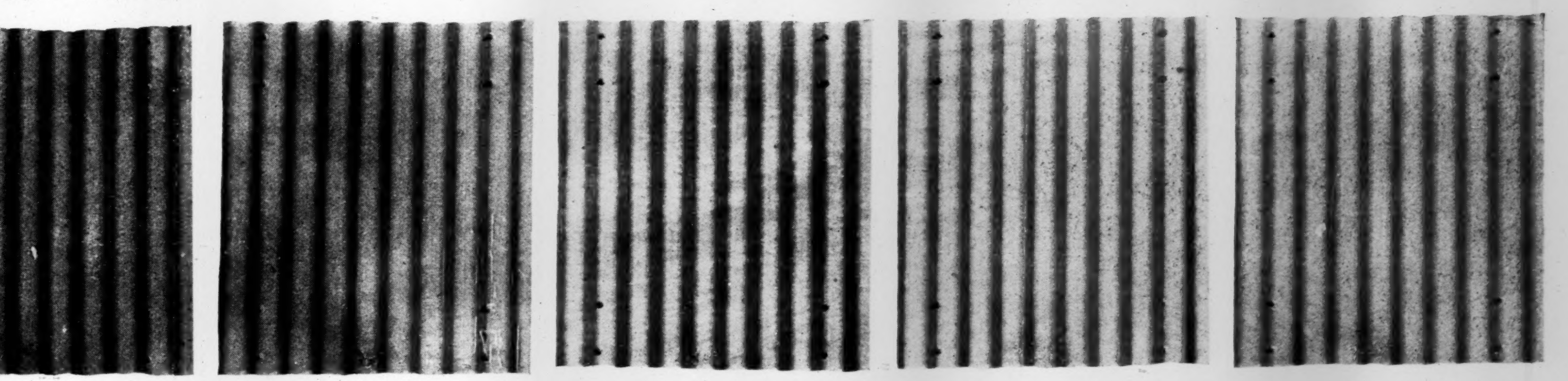
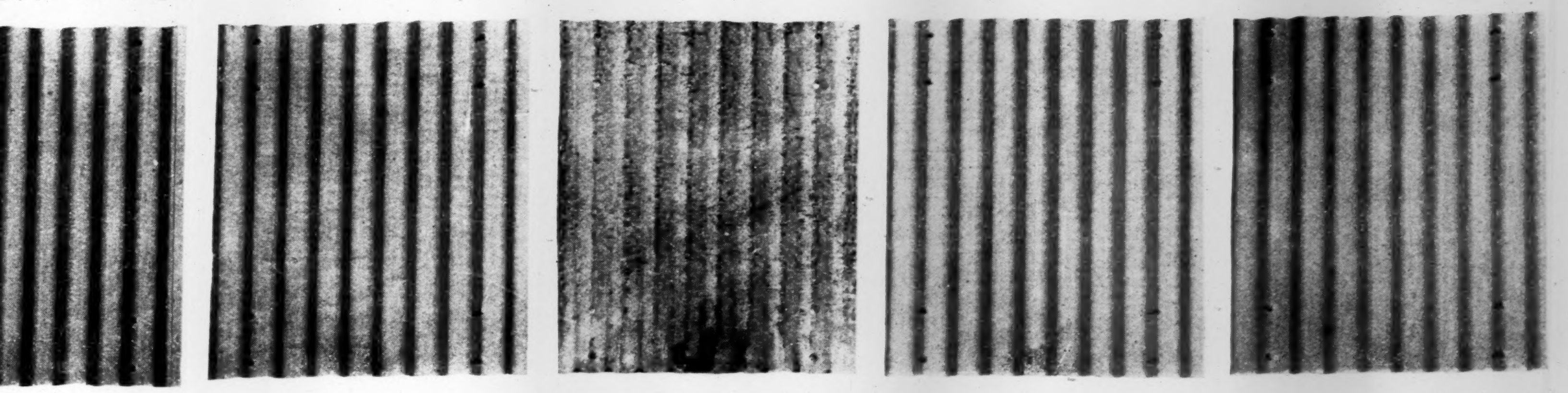


ge, 2.5-oz. coating.



ge, 2.0-oz. coating.

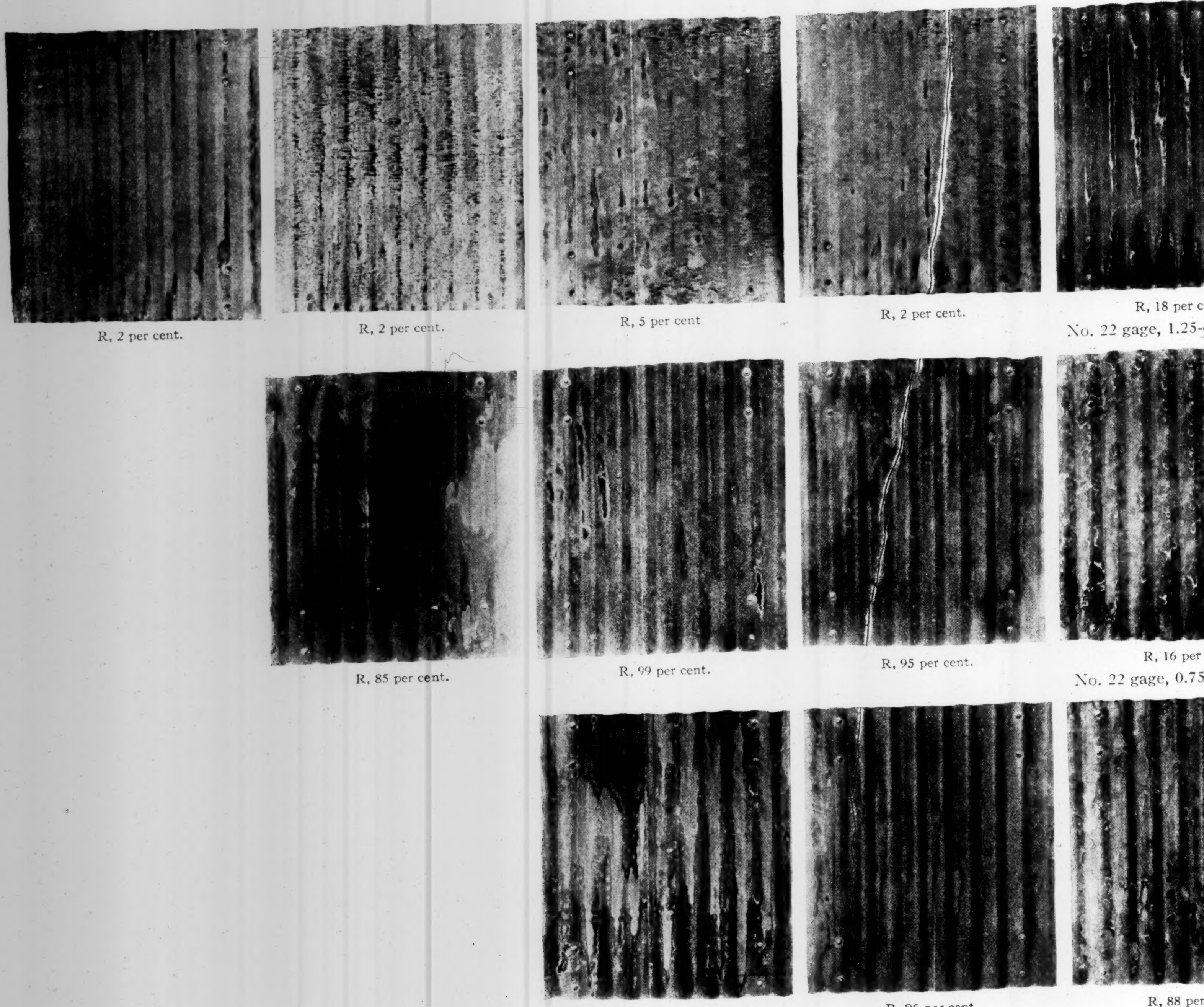


R, 1 per cent.

ge, 1.5-oz. coating.

ack, West Side, October 27, 1928.

es base metal rust.



R, 2 per cent.

R, 2 per cent.

R, 5 per cent

R, 2 per cent.

R, 18 per c

No. 22 gage, 1.25-

R, 85 per cent.

R, 99 per cent.

R, 95 per cent.

R, 16 per

No. 22 gage, 0.75

R, 59 per cent.

R, 96 per cent.

R, 88 per

No. 28 gage, 0.7

Fig. 2.—Altoona Test Rack, W

R signifies base

PLATE V.
PROC. AM. SOC. TESTING MATS.
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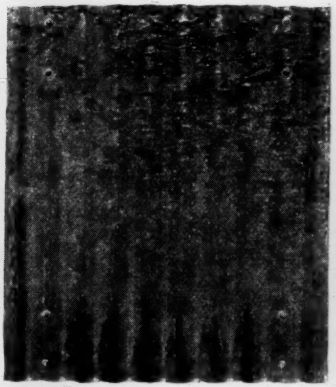
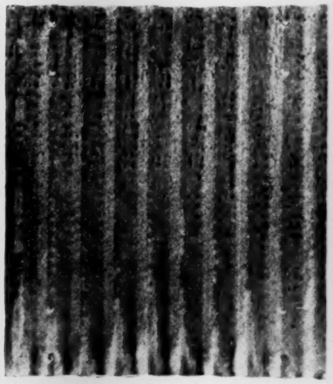
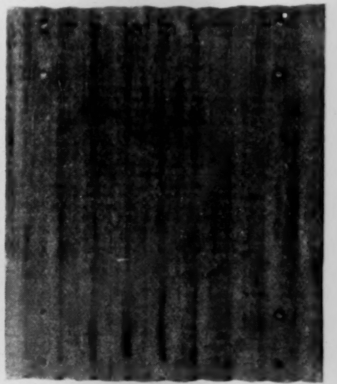
18 per cent.

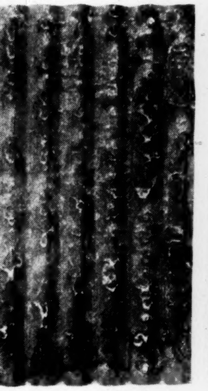
R, 3 per cent.

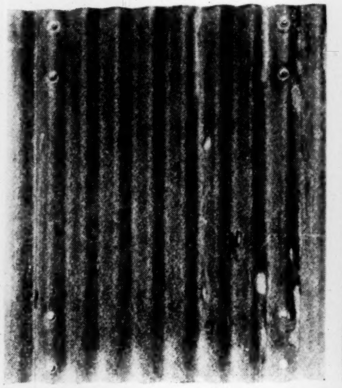

R, 4 per cent.

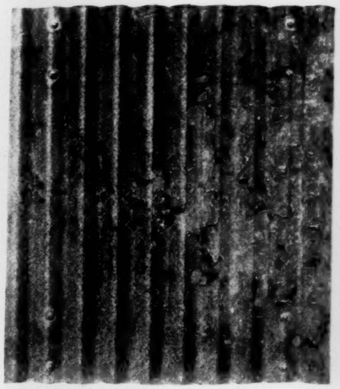

R, 2 per cent.

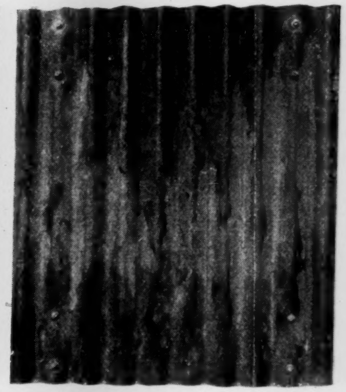

R, 3 per cent.

e, 1.25-oz. coating.

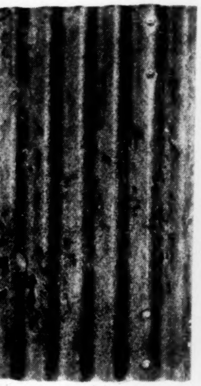

16 per cent.

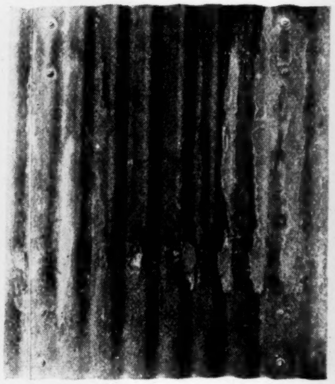

R, 97 per cent.

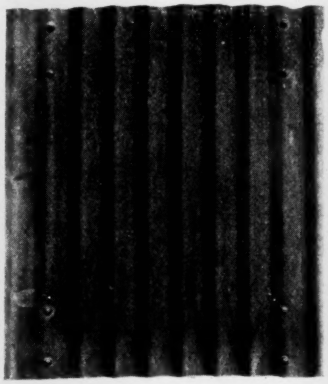

R, 77 per cent.


R, 68 per cent.

, 0.75-oz. coating.


38 per cent.

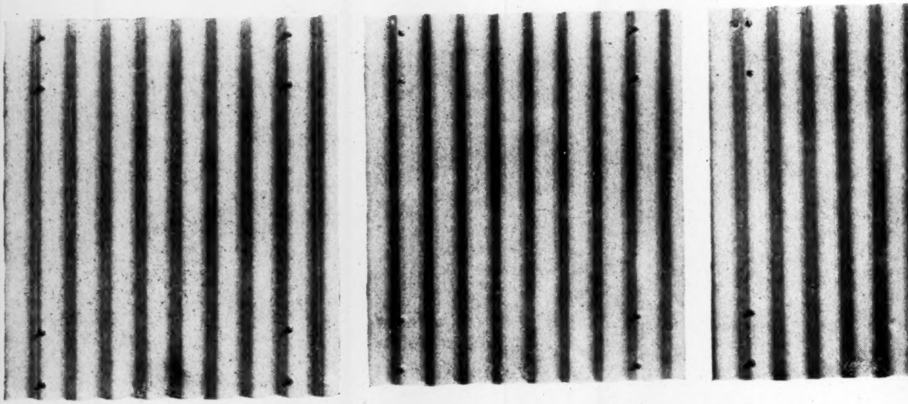

R, 85 per cent.


R, 97 per cent.

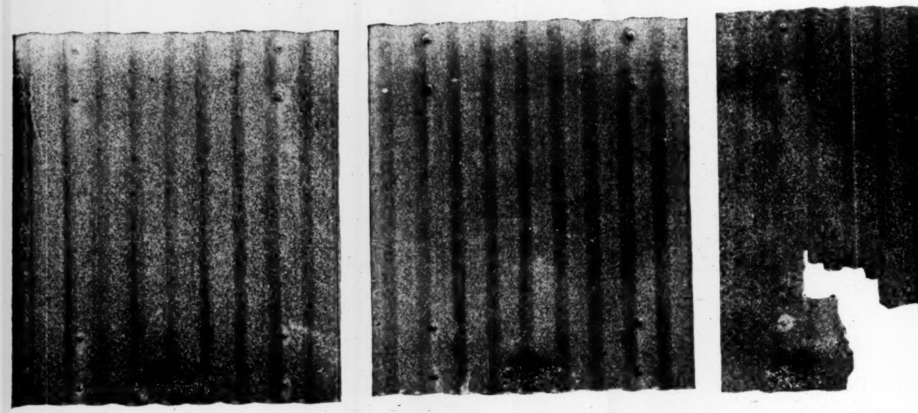
, 0.75-oz. coating.

k, West Side, October 27, 1928.

base metal rust.



No. 16 gage, 2.5-oz. c



No. 22 gage, uncoat

FIG. 3.—Altoona Test Rack, W

PLATE VI.
PROC. AM. SOC. TESTING MATS.
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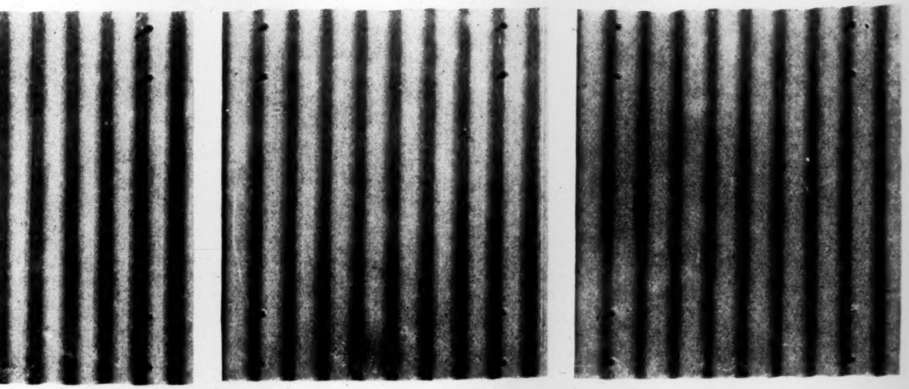
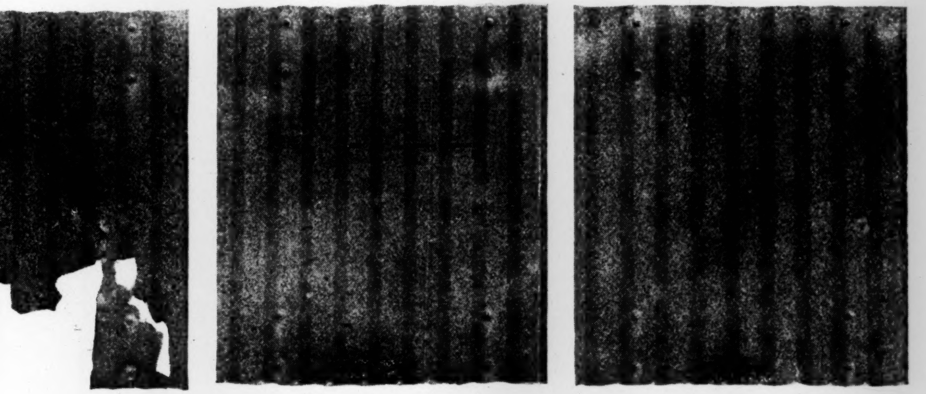


5-oz. coating.



ncoated black sheets.

ck, West Side, October 27, 1928.

The differences in color, texture and adherence of rust found in the previous black sheet test of Committee A-5 have been confirmed at Altoona and Brunot Island, but at the present time at Sandy Hook, Key West and State College, the sheets appear similar.

In the following table are shown all No. 22 gage black sheet failures which have occurred in 2.75 years:

LOCATION	SHEET	LIFE IN YEARS
Altoona	YV-T	2.0
Brunot Island	RZ-T	2.0
	UX-T	2.5
	YH-B	2.0
	VC-B	2.3
Key West	YZ-T	2.7

WIRE AND FENCING

Due to pressure of work in connection with collection, assortment and erection of hardware, structural shapes, conduits, etc., the field test work on wire and fencing has been delayed, but it is hoped that it will be successfully completed within a few months. Owing to additional space required for the hardware samples, the erection of additional wire racks may be necessary.

HARDWARE, STRUCTURAL SHAPES, CONDUITS, ETC.

The various samples of hardware, structural shapes, conduits, etc., were collected after many difficulties and delays, and, after having been carefully assorted and labelled, were shipped, together with various accessory materials, such as lumber, angles, bolts, etc., to the five test racks.

Originally, wooden telephone cross-arms were mounted on the uprights, but these were found to be too frail to support the weight of the samples and were replaced with 3 by 4-in. wood stringers, bolted to 3 by 3-in. sherardized angle cross-arms, which in turn were attached to upright angles imbedded in concrete. In addition, the concrete upright supports at State College, Pa., which showed signs of weakening, were replaced with 6-in. sherardized channels.

Erection of the specimens, carried out under the supervision and direction of several members of the staff of the Schenectady Testing Laboratory of the General Electric Co., in order to save time and expense to the members at large of the sub-committee, was begun about December 17, 1928, and completed about the third week in January, 1929, the racks being erected in the following order: Sandy Hook, N. J.; Altoona, Pa.; State College, Pa.; Pittsburgh, Pa.; and Key West, Fla.

Eleven bays were utilized for the erection of these specimens and the plan, followed at each rack, is shown in Figs. 4 to 14, appended hereto. With very few changes, the original program[1] was followed. Owing to difficulty in securing sprayed zinc samples, these were replaced in most instances by "amaloy" coated samples.

Arrangements will be made shortly by the Inspection Sub-Group on Hardware, under the chairmanship of R. L. Duff, Metallurgical Engineer, Standard Oil Development Co., to sample, analyze and classify the various remaining specimens as to character, weight of coating, etc.

TEST RACKS

A section has been appointed to investigate thoroughly the question of examination of the atmospheres at each test rack location and to report on the question of advisability of establishing any additional test racks.

This report was considered by the sub-committee at a meeting in Chicago on March 19, 1929, and was unanimously approved.

Respectfully submitted on behalf of the sub-committee,

F. A. HULL,
Chairman.

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[1] See 1927 Report of Sub-Committee VIII, of Committee A-5, on Field Tests of Metallic Coatings, ***Proceedings***, Am. Soc. Testing Mats., Vol. 27, Part I, p. 191 (1927).

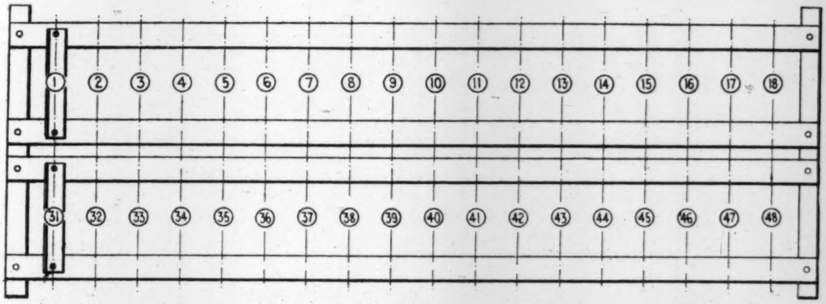

FIG. 4.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 1.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	3 by 3 by $\frac{5}{16}$-in. plain steel angles	Electro galvanized	Meaker Co.
Nos. 4 to 6		Hot dip galvanized	Ritter-Connelly Co.
Nos. 7 to 9		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 10 to 12		Cadmium plated	General Electric Co.
Nos. 13 to 15		Sherardized	General Electric Co.
Nos. 16 to 18		Lead plated	Locomotive Terminal Improvement Co.
Nos. 31 to 33	3 by 3 by $\frac{5}{16}$-in. copper bridge steel angles	Electro galvanized	Meaker Co.
Nos. 34 to 36		Hot dip galvanized	Ritter-Connelly Co.
Nos. 37 to 39		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 40 to 42		Cadmium plated	General Electric Co.
Nos. 43 to 45		Sherardized	General Electric Co.
Nos. 46 to 48		Lead plated	Locomotive Terminal Improvement Co.

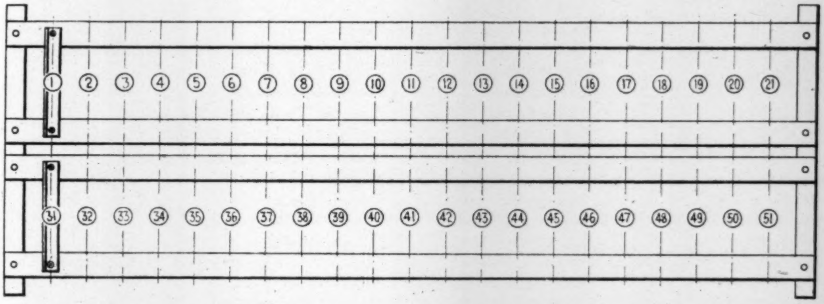

FIG. 5.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 2.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	2 by $1\frac{1}{2}$ by $\frac{3}{16}$-in. plain steel angles	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	General Electric Co.
Nos. 7 to 9		Hot dip galvanized	Ritter-Connelly Co.
Nos. 10 to 12		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 13 to 15		Cadmium plated	General Electric Co.
Nos. 16 to 18		Sherardized	General Electric Co.
Nos. 19 to 21		Lead plated	Locomotive Terminal Improvement Co.
Nos. 31 to 33	2 by $1\frac{1}{2}$ by $\frac{3}{16}$-in. copper bridge steel angles	Electro galvanized	Meaker Co.
Nos. 34 to 36		Electro galvanized	General Electric Co.
Nos. 37 to 39		Hot dip galvanized	Ritter-Connelly Co.
Nos. 40 to 42		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 43 to 45		Cadmium plated	General Electric Co.
Nos. 46 to 48		Sherardized	General Electric Co.
Nos. 49 to 51		Lead plated	Locomotive Terminal Improvement Co.

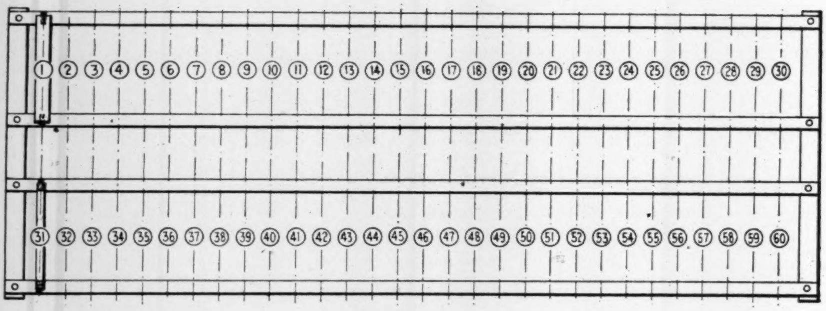
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FIG. 6.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 3.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	2-in. conduit	Electro galvanized	Meaker Co.
Nos. 4 to 6		Hot dip galvanized	General Electric Co.
Nos. 7 to 9		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 10 to 12		Cadmium plated	General Electric Co.
Nos. 13 to 15		Cadmium plated	Westinghouse Electric and Manufacturing Co.
Nos. 16 to 18		Sherardized	Semet-Solvay Corp.
Nos. 19 to 21		Sherardized	General Electric Co.
Nos. 22 to 24		Sherardized	National Metal Moulding Co.
Nos. 25 to 27		Lead plated	Locomotive Terminal Improvement Co.
Nos. 28 to 30	1-in. conduit	Amaloy	American Machine and Foundry Co.
Nos. 31 to 33		Electro galvanized	Meaker Co.
Nos. 34 to 36		Hot dip galvanized	General Electric Co.
Nos. 37 to 39		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 40 to 42		Cadmium plated	General Electric Co.
Nos. 43 to 45		Cadmium plated	Westinghouse Electric and Manufacturing Co.
Nos. 46 to 48		Sherardized	Semet-Solvay Corp.
Nos. 49 to 51		Sherardized	General Electric Co.
Nos. 52 to 54		Sherardized	National Metal Moulding Co.
Nos. 55 to 57		Calorizing	Calorizing Co.
Nos. 58 to 60		Lead plated	Locomotive Terminal Improvement Co.

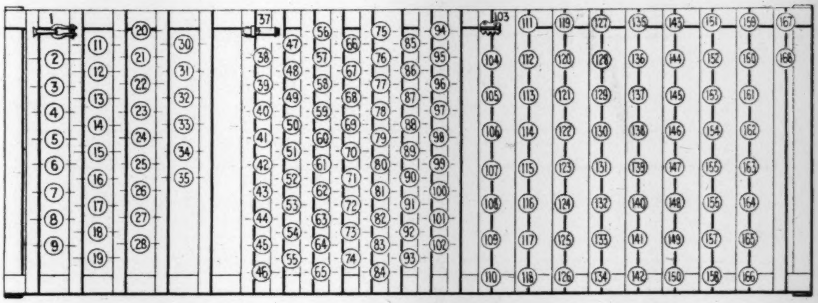
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FIG. 7.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 4.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	Forged steel tower fittings	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	Ohio Brass Co.
Nos. 7 to 9		Hot dip galvanized	Locke Insulator Corp.
Nos. 11 to 13		Hot dip galvanized	Diamond Expansion Bolt Co.
Nos. 14 to 16		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 17 to 19		Cadmium plated	General Electric Co.
Nos. 20 to 22		Sherardized	General Electric Co.
Nos. 23 to 25		Sherardized	Westinghouse Elec. and Mfg. Co.
Nos. 26 to 28		Parkerized	Parker Rust Proof Co.
Nos. 30 to 32		Cadmium plated	Westinghouse Elec. and Mfg. Co.
Nos. 33 to 35		Lead plated	Locomotive Terminal Improvement Co.
Nos. 37 to 39	$\frac{3}{4}$-in. nipple and ell	Malleable iron, electro galvanized	Meaker Co.
Nos. 40 to 42		Cast iron, electro galvanized	Meaker Co.
Nos. 43 to 45		Malleable iron, electro galvanized	Ohio Brass Co.
Nos. 46 to 48		Cast iron, electro galvanized	Ohio Brass Co.
Nos. 49 to 51		Malleable iron, hot dip galvanized	Diamond Expansion Bolt Co.
Nos. 52 to 54		Cast iron, hot dip galvanized	Diamond Expansion Bolt Co.
Nos. 55 to 57		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 58 to 60		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 61 to 63		Malleable iron, cadmium plated	Westinghouse Elec. and Mfg. Co.
Nos. 64 to 66		Cast iron, cadmium plated	Westinghouse Elec. and Mfg. Co.
Nos. 67 to 69		Malleable iron, cadmium plated	General Electric Co.
Nos. 70 to 72		Cast iron, cadmium plated	General Electric Co.
Nos. 73 to 75		Malleable iron, sherardized	Wise Industries Inc.
Nos. 76 to 78		Cast iron, sherardized	Wise Industries Inc.
Nos. 79 to 81		Malleable iron, sherardized	Westinghouse Elec. and Mfg. Co.
Nos. 82 to 84		Cast iron, sherardized	Westinghouse Elec. and Mfg. Co.
Nos. 85 to 87		Malleable iron, Parkerized	Parker Rust Proof Co.
Nos. 88 to 90		Cast iron, Parkerized	Parker Rust Proof Co.
Nos. 91 to 93		Malleable iron, sherardized	General Electric Co.
Nos. 94 to 96		Cast iron, sherardized	General Electric Co.
Nos. 97 to 99		Malleable iron, amaloy	American Machine and Fdy. Co.
Nos. 100 to 102		Cast iron, amaloy	American Machine and Fdy. Co.
Nos. 103 to 105	Tower clamps	Malleable iron, electro galvanized	Meaker Co.
Nos. 106 to 108		Cast iron, electro galvanized	Meaker Co.
Nos. 109 to 111		Malleable iron, electro galvanized	Ohio Brass Co.
Nos. 112 to 114		Cast iron, electro galvanized	Ohio Brass Co.
Nos. 115 to 117		Malleable iron, hot dip galvanized	Diamond Expansion Bolt Co.
Nos. 118 to 120		Cast iron, hot dip galvanized	Diamond Expansion Bolt Co.
Nos. 121 to 123		Malleable iron, hot dip galvanized	Locke Insulator Corp.
Nos. 124 to 126		Cast iron, hot dip galvanized	Locke Insulator Corp.
Nos. 127 to 129		Malleable iron, cadmium plated	Westinghouse Elec. and Mfg. Co.
Nos. 130 to 132		Cast iron, cadmium plated	Westinghouse Elec. and Mfg. Co.
Nos. 133 to 135		Malleable iron, cadmium plated	General Electric Co.
Nos. 136 to 138		Cast iron, cadmium plated	General Electric Co.
Nos. 139 to 141		Malleable iron, sherardized	Wise Industries Inc.
Nos. 142 to 144		Cast iron, sherardized	Wise Industries Inc.
Nos. 145 to 147		Malleable iron, sherardized	Westinghouse Elec. and Mfg. Co.
Nos. 148 to 150		Cast iron, sherardized	Westinghouse Elec. and Mfg. Co.
Nos. 151 to 153		Malleable iron, Parkerized	Parker Rust Proof Co.
Nos. 154 to 156		Cast iron, Parkerized	Parker Rust Proof Co.
Nos. 157 to 159		Malleable iron, hot dip aluminum	Babcock & Wilcox Co.
Nos. 160 to 162		Cast iron, hot dip aluminum	Babcock & Wilcox Co.
Nos. 163 to 165		Malleable iron, amaloy	American Machine and Fdy. Co.
Nos. 166 to 168		Cast iron, amaloy	American Machine and Fdy. Co.

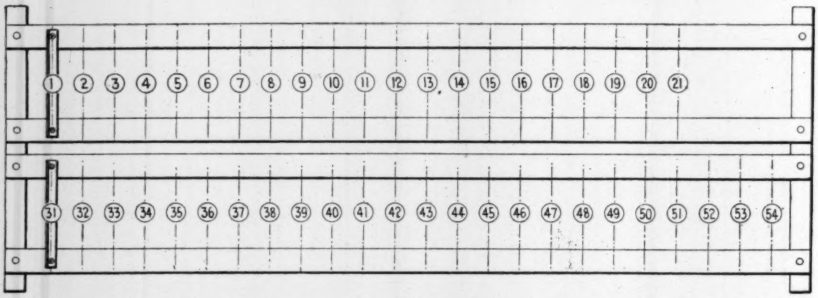

FIG. 8.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 5.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	$1\frac{1}{2}$ by $1\frac{1}{2}$ by $\frac{1}{8}$-in. plain steel angles	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	General Electric Co.
Nos. 7 to 9		Hot dip galvanized	Ritter-Connelly Co.
Nos. 10 to 12		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 13 to 15		Cadmium plated	General Electric Co.
Nos. 16 to 18		Sherardized	General Electric Co.
Nos. 19 to 21		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 31 to 33	$1\frac{1}{2}$ by $1\frac{1}{2}$ by $\frac{1}{8}$-in. copper bridge steel angles	Electro galvanized	Meaker Co.
Nos. 34 to 36		Electro galvanized	General Electric Co.
Nos. 37 to 39		Hot dip galvanized	Ritter-Connelly Co.
Nos. 40 to 42		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 43 to 45		Cadmium plated	General Electric Co.
Nos. 46 to 48		Sherardized	General Electric Co.
Nos. 49 to 51		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 52 to 54		Lead plated	Locomotive Terminal Improvement Co.

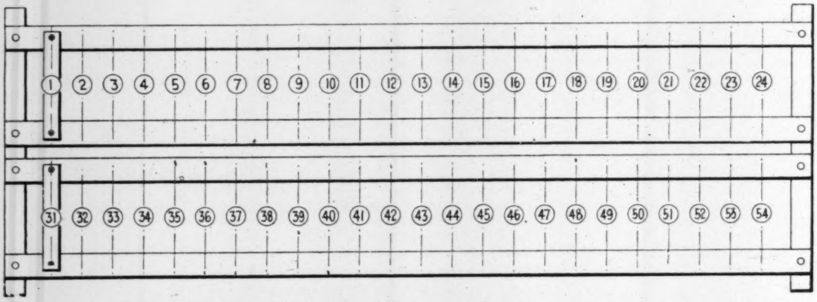

FIG. 9.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 6.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	No. 14 by $2\frac{1}{2}$-in. plain steel flats	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	General Electric Co.
Nos. 7 to 9		Hot dip galvanized	Ritter-Connelly Co.
Nos. 10 to 12		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 13 to 15		Cadmium plated	General Electric Co.
Nos. 16 to 17		Sherardized	General Electric Co.
Nos. 18 to 20		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 21 to 24		Lead plated	Locomotive Terminal Improvement Co.
Nos. 31 to 33	No. 14 by $2\frac{1}{2}$-in. copper bridge steel flats	Electro galvanized	Meaker Co.
Nos. 34 to 36		Electro galvanized	General Electric Co.
Nos. 37 to 39		Hot dip galvanized	Ritter-Connelly Co.
Nos. 40 to 42		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 43 to 45		Cadmium plated	General Electric Co.
Nos. 46 to 48		Sherardized	General Electric Co.
Nos 49 to 51		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 52 to 54		Lead plated	Locomotive Terminal Improvement Co.

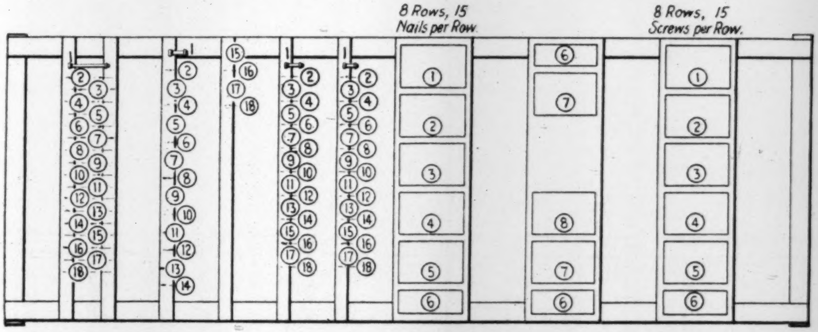

FIG. 10.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 7.

¼ by 6-in. Bolts

Nos. 1 to 3	Sherardized by Westinghouse Electric and Manufacturing Co.
Nos. 4 to 6	Sherardized by Pittsburgh Bolt and Screw Co.
Nso 7 to 9	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 10 to 12	Electric galvanized by Pittsburgh Bolt and Screw Co.
Nos. 13 to 15	Cadmium plated by Pittsburgh Bolt and Screw Co.
Nos. 16 to 18	Cadmium plated by Westinghouse Electric and Manufacturing Co.

⅝ by 2½-in. Bolts

Nos. 1 to 3	Sherardized by Pittsburgh Bolt and Screw Co.
Nos. 4 to 6	Sherardized by Westinghouse Electric and Manufacturing Co.
Nos. 7 to 9	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 10 to 12	Cadmium plated by Westinghouse Electric and Manufacturing Co.
Nos. 13 to 15	Cadmium plated by Pittsburgh Bolt and Screw Co.
Nos. 16 to 18	Electro galvanized by Pittsburgh Bolt and Screw Co.

½ by 2½-in. Bolts

Nos. 1 to 3	Sherardized by Pittsburgh Bolt and Screw Co.
Nos. 4 to 6	Sherardized by General Electric Co.
Nos. 7 to 9	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 10 to 12	Electro galvanized by Western Electric Co.
Nos. 13 to 15	Electro galvanized by Pittsburgh Bolt and Screw Co.
Nos. 16 to 18	Cadmium plated by Pittsburgh Bolt and Screw Co.

⅜ by 1½-in. Bolts

Nos. 1 to 3	Sherardized by Pittsburgh Bolt and Screw Co.
Nos. 4 to 6	Sherardized by General Electric Co.
Nos. 7 to 9	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 10 to 12	Electro galvanized by Pittsburgh Bolt and Screw Co.
Nos. 13 to 15	Cadmium plated by Westinghouse Electric and Manufacturing Co.
Nos. 16 to 18	Cadmium plated by Pittsburgh Bolt and Screw Co.

1-in. Roofing Nails

No. 1	Sherardized by Westinghouse Electric and Manufacturing Co.
No. 2	Sherardized by General Electric Co.
No. 3	Cadmium plated by Westinghouse Electric and Manufacturing Co.
No. 4	Hot dip galvanized by Diamond Expansion Bolt Co.
No. 5	Hot dip galvanized by Hubbard Co.
No. 6	Electro galvanized by Ohio Brass Co.
No. 7	Amaloy by American Machine and Foundry Co.

No. 14 by 2½-in. Wood Screws

No. 1	Sherardized by Westinghouse Electric and Manufacturing Co.
No. 2	Sherardized by General Electric Co.
No. 3	Cadmium plated by Westinghouse Electric and Manufacturing Co.
No. 4	Hot dip galvanized by Diamond Expansion Bolt Co.
No. 5	Cadmium plated by General Electric Co.
No. 6	Hot dip galvanized by Hubbard Co.
No. 7	Parkerized by Parker Rust Proof Co.
No. 8	Electro galvanized by Ohio Brass Co.

This material list is for all installations except Key West. On the Key West installation the order of placing roofing nails was changed as follows:

1-in. Roofing Nails

No. 1	Electro galvanized by Ohio Brass Co.
No. 2	Hot dip galvanized by Hubbard Co.
No. 3	Hot dip galvanized by Diamond Expansion Bolt Co.
No. 4	Cadmium plated by Westinghouse Electric and Manufacturing Co.
No. 5	Sherardized by General Electric Co.
No. 6	Sherardized by Westinghouse Electric and Manufacturing Co.
No. 7	Amaloy by American Machine and Foundry Co.

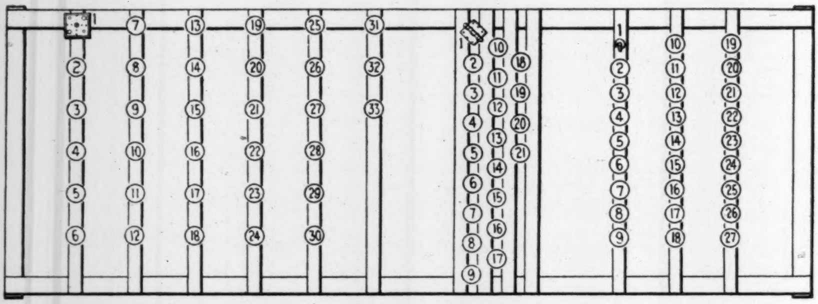

FIG. 11.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 8.

Knock-Out Boxes

Nos. 1 to 3	Electro galvanized by Meaker Co.
Nos. 4 to 6	Electro galvanized by Ohio Brass Co.
Nos. 7 to 9	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 10 to 12	Cadmium plated by General Electric Co.
Nos. 13 to 15	Cadmium plated by Westinghouse Electric and Manufacturing Co.
Nos. 16 to 18	Sherardized by Wise Industries Inc.
Nos. 19 to 21	Sherardized by Westinghouse Electric and Manufacturing Co.
Nos. 22 to 24	Sherardized by General Electric Co.
Nos. 25 to 27	Parkerized by Parker Rust Proof Co.
Nos. 28 to 30	Amaloy by American Machine and Foundry Co.
Nos. 31 to 33	Hot dip aluminum by Babcock & Wilcox Co.

Hinges

Nos. 1 to 3	Cadmium plated by Westinghouse Electric and Manufacturing Co.
Nos. 4 to 6	Cadmium plated by General Electric Co.
Nos. 7 to 9	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 10 to 12	Sherardized by General Electric Co.
Nos. 13 to 15	Sherardized by Westinghouse Electric and Manufacturing Co.
Nos. 16 to 18	Parkerized by Parker Rust Proof Co.
Nos. 19 to 21	Electro galvanized by General Electric Co.

Bull Dog Clamps

Nos. 1 to 3	Electro galvanized by Meaker Co.
Nos. 4 to 6	Hot dip galvanized by Diamond Expansion Bolt Co.
Nos. 7 to 9	Cadmium plated by Westinghouse Electric and Manufacturing Co.
Nos. 10 to 12	Cadmium plated by General Electric Co.
Nos. 13 to 15	Sherardized by Westinghouse Electric and Manufacturing Co.
Nos. 16 to 18	Sherardized by General Electric Co.
Nos. 19 to 21	Sherardized by Wise Industries Inc.
Nos. 22 to 24	Hot dip aluminum by Babcock & Wilcox Co.
Nos. 25 to 27	Parkerized by Parker Rust Proof Co.

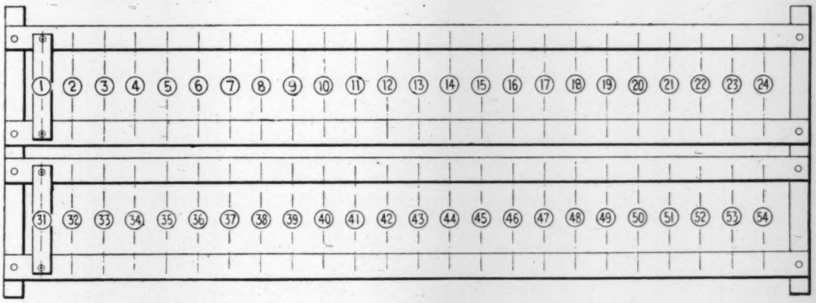

FIG. 12.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 9.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	$\frac{1}{4}$ by 3-in. plain steel flats	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	General Electric Co.
Nos. 7 to 9		Hot dip galvanized	Ritter-Connelly Co.
Nos. 10 to 12		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 13 to 15		Cadmium plated	General Electric Co.
Nos. 16 to 18		Sherardized	General Electric Co.
Nos. 19 to 21		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 22 to 24		Lead plated	Locomotive Terminal Improvement Co.
Nos. 31 to 33	$\frac{1}{4}$ by 3-in. copper bridge steel flats	Electro galvanized	Meaker Co.
Nos. 34 to 36		Electro galvanized	General Electric Co.
Nos. 37 to 39		Hot dip galvanized	Ritter-Connelly Co.
Nos. 40 to 42		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 43 to 45		Cadmium plated	General Electric Co.
Nos. 46 to 48		Sherardized	General Electric Co.
Nos. 49 to 51		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 52 to 54		Lead plated	Locomotive Terminal Improvement Co.

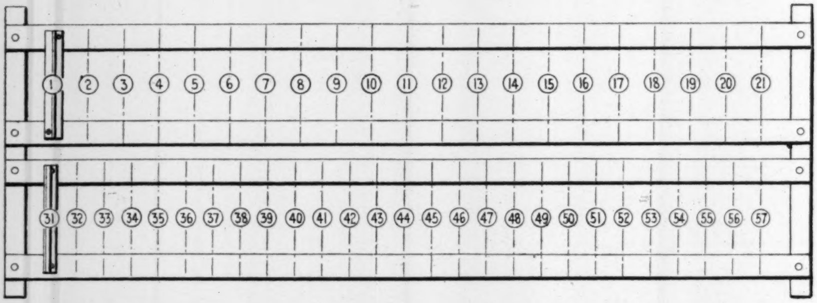

FIG. 13.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 10.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	Section No. 209	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	General Electric Co.
Nos. 7 to 9		Hot dip galvanized	Ritter-Connelly Co.
Nos. 10 to 12		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 13 to 15		Cadmium plated	General Electric Co.
Nos. 16 to 18		Sherardized	General Electric Co.
Nos. 19 to 21		Lead plated	American Machine and Foundry Co.
Nos. 31 to 33	Section No. 792	Electro galvanized	Meaker Co.
Nos. 34 to 36		Electro galvanized	General Electric Co.
Nos. 37 to 39		Hot dip galvanized	Ritter-Connelly Co.
Nos. 40 to 42		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 43 to 45		Cadmium plated	General Electric Co.
Nos. 46 to 48		Cadmium plated	Westinghouse Electric and Manufacturing Co.
Nos. 49 to 51		Sherardized	General Electric Co.
Nos. 52 to 54		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 55 to 57		Parkerized	Parker Rust Proof Co.

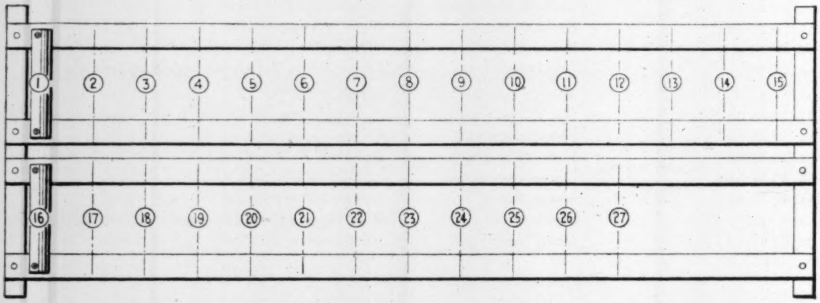

FIG. 14.—Diagram Showing Placing of Specimens on Test Racks, Bay No. 13.

SPECIMEN		COATING	PROCESSOR
Nos. 1 to 3	Section No. 161	Electro galvanized	Meaker Co.
Nos. 4 to 6		Electro galvanized	General Electric Co.
Nos. 7 to 9		Hot dip galvanized	Ritter-Connelly Co.
Nos. 10 to 12		Hot dip aluminum	Babcock & Wilcox Co.
Nos. 13 to 15		Cadmium plated	General Electric Co.
Nos. 16 to 18		Cadmium plated	Westinghouse Electric and Manufacturing Co.
Nos. 19 to 21		Sherardized	General Electric Co.
Nos. 22 to 24		Sherardized	Westinghouse Electric and Manufacturing Co.
Nos. 25 to 27		Parkerized	Parker Rust Proof Co.

REPORT OF SECTIONAL COMMITTEE
ON
ZINC COATING OF IRON AND STEEL

The sectional committee has held one meeting during the year and submits the following report of its activities:

Technical Committee I on Hardware and Fastenings (A. L. Fox, chairman).—This technical committee has been reorganized during the year and has mapped out a program of future work.

Technical Committee II on Sheets and Sheet Products (G. A. Reinhardt, chairman).—This technical committee makes no further recommendation concerning the Proposed Specifications for the Zinc Coating of Iron and Steel Sheets which were accepted for publication a year ago, without, however, being adopted by the sponsor. No action was taken by the Sectional Committee on these specifications, which, therefore, are to be continued in their present status.

Technical Committee III on Structural Products (V. F. Hammel, chairman).—This technical committee is submitting revisions in the Tentative Specifications for Zinc (Hot-Galvanized) Coatings on Structural Steel Shapes, Plates, Bars and their Products (A 123 - 28 T).[1] The revisions were approved by the sectional committee and are now reported with the recommendation that they be accepted by the sponsor and that the specifications as revised be continued as tentative. It was again the vote of the sectional committee that the sponsor should not offer these tentative specifications for formal approval by the American Standards Association at the present time. The revised specifications are appended hereto.[2] The revisions comprise a reference to the Standard Methods of Determining Weight of Coating on Zinc-Coated Articles (A 90 - 24) for the determination of the weight of zinc coating for material manufactured without inspection. The section on finish and adherence of coating has been expanded and the section on bare area deleted. A requirement was added in the inspection clause to the effect that the purchaser must defray the expense of analysis of the samples of spelter.

Technical Committee IV on Pipes, Conduits and Their Fittings (F. N. Speller, chairman).—This sub-committee has received no comments of any sort on the Proposed Specifications for Zinc Coatings

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 748 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 99.

[2] See p. 585.—Ed.

(Galvanizing) on Iron or Steel Pipe and Fittings published as information a year ago, and recommends that the specifications be continued as at present and that the request for comment or criticism be emphasized.

At the meeting of the sectional committee held on March 21, the following resolution was proposed and after discussion adopted:

> That the executive committee of the sectional committee consider the disbanding of said sectional committee and that if the executive committee should favorably act in the matter, it should recommend such disbandment to the sponsor body, the American Society for Testing Materials, with the request that such recommendation be transmitted to the American Standards Association, it being understood that such favorable action would simply transfer the pending work of the Technical Committees to corresponding committees of the sponsor body.

In accordance with the foregoing resolution, a meeting of the executive committee was held, at which there were present, in addition to all of the members of the executive committee, the secretary of the sponsor body and a representative of one of the other member bodies. The resolution was debated at length, together with the reasons for it which were advanced, namely, that the work of the sectional committee is largely a duplication of work being carried on by substantially the same individuals as members of the American Society for Testing Materials committees; that the more formal representation of member bodies by the individuals on the committee acts as a deterrent to progress; that there is an apparent disinclination to attempt the writing of specifications when it is realized that there is needed much fundamental data not yet available, but which will become available on the completion of programs now actively under way in the American Society for Testing Materials committees. Argument against the resolution was largely founded on the claim that industry is urgently in need of specifications representing the present state of the art, even though it is clearly understood that the specifications that might be written today might be completely revised within a very short time.

The executive committee realized that it of itself could not take formal action such as is contemplated by the resolution, and, therefore, voted to request the secretary of the sponsor body to present the resolution, together with a statement concerning the reasons leading up to it, to the officers of the member bodies on the sectional committee and that he develop the consensus of the member bodies and, if possible, transmit to the sectional committee the instructions of the member bodies concerning the future procedure of the sectional committee.

The recommendation appearing in this report has been submitted to letter ballot of the sectional committee with the following result:

Item.	Affirmative	Negative	Not Voting
PROPOSED REVISION OF TENTATIVE STANDARD.			
Tentative Specifications for Zinc Coatings on Structural Shapes (A 123 - 28 T)	26	2	0

This report has been submitted to letter ballot of the sectional committee, which consists of 49 members, 28 members returned their ballots, of whom 27 have voted affirmatively.

Respectfully submitted on behalf of the sectional committee,

J. A. CAPP,
Chairman.

S. S. TUTHILL,
Secretary.

EDITORIAL NOTE

The proposed revision of the Tentative Specifications for Zinc (Hot-Galvanized) Coatings on Structural Steel Shapes, Plates and Bars and Their Products was accepted. The tentative specifications in their revised form appear on page 585.

REPORT OF COMMITTEE A-6
ON
MAGNETIC PROPERTIES

Two meetings of Committee A-6 have been held during the past year with a large percentage of the members in attendance at each meeting.

The committee recommends for publication as tentative the following revision of the Standard Methods of Test for Magnetic Properties of Iron and Steel (A 34 – 28),[1] consisting of an increase in the maximum magnetic force from which the standard data for magnet steel shall be obtained:

Section 5. (c).—Change to read as follows by the addition of the italicized figures and the omission of those in brackets:

> (c) For permanent magnet steel, the residual induction and coercive force shall be determined from the maximum normal induction corresponding to a magnetizing force of [200] *300* gilberts per cm. unless the maximum permeability is less than 100, in which case the maximum magnetizing force shall be not less than 2½ times the value of the magnetizing force at which this maximum permeability occurs and shall be some multiple of [200] *300*.

Sub-Committee I on Definitions and Nomenclature (W. J. Shackelton, chairman).—A list of magnetic terms, units and symbols, submitted for discussion last year[2] is being proposed to the Society for adoption as a tentative standard with a few slight modifications in line with the suggestions from Committee E-8 on Nomenclature and Definitions which committee has reviewed the list. The definitions of terms as revised are appended hereto.[3]

Sub-Committee II on Tests at Low Induction and High Frequencies (R. L. Sanford, chairman).—This sub-committee has been doing considerable experimental work with various bridge circuits but has been unable to agree on standards for tests at commercial frequencies and low inductions. It is hoped that suitable specifications will be available within a few months.

Sub-Committee III on Tests at High Magnetizing Forces (L. E. Howard, chairman).—This sub-committee has been active during the past year. One committee meeting was held at which further comparative tests between different permeameters and methods were discussed. Serious discrepancies between different apparatus and methods when testing at high magnetizing forces have developed, and a solution of this difficulty is not readily apparent. This investigation will be continued along somewhat new lines, having for its object the measurement of magnetizing force without the errors due to flux leakage which so far have been found difficult to control.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 29.

[2] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 182 (1928).

[3] See p. 589.—Ed.

The following is the result of the letter ballot of the committee on the recommendations made in this report:

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARD			
Proposed Tentative Definitions of Terms, with Units and Symbols, Relating to Magnetic Testing	11	1	2
II. PROPOSED TENTATIVE REVISION OF STANDARD			
Standard Methods of Test for Magnetic Properties of Iron and Steel (A 34 - 28)	12	0	2

This report has been submitted to letter ballot of the committee, which consists of 14 members; 12 members returned their ballots, of whom 12 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee.

THOMAS SPOONER,
Chairman.

R. L. SANFORD,
Secretary.

EDITORIAL NOTE

The proposed Tentative Definitions of Terms, with Units and Symbols, Relating to Magnetic Testing were accepted for publication as tentative and appear on page 589.

The proposed tentative revision of the Standard Methods of Test for Magnetic Properties of Iron and Steel was accepted for publication as tentative and appears on page 858.

REPORT OF COMMITTEE A-8
ON
MAGNETIC ANALYSIS

The committee held a meeting in conjunction with the annual meeting of the Society at Atlantic City on June 27, 1928, at which all members but two were present or represented. Further business of the committee has been carried on during the year by correspondence.

In addition to serving as a clearing house for the interchange of data and experience regarding individual investigations carried on by its members, the committee has initiated a new investigation which is now well under way. While various members are cooperating in the work, it is being headed up by a small sub-committee under the leadership of Mr. Haakon Styri. The investigation has for its object a study of the relationship between magnetic properties and toughness, as indicated by the results of impact tests. The work is being carried out initially on a 1.5-per-cent chromium steel of typical composition, such as is used in the manufacture of ball bearings.

In addition to the magnetic and impact tests, hardness and microstructure will also be determined. If satisfactory results are obtained, it is possible that the work will be extended to other types of steel.

Several investigations in the field of magnetic analysis are being carried on by members of the committee but none of them has advanced to such a stage that technical reports are warranted at the present time.

This report has been submitted to letter ballot of the committee, which consists of 13 members; 13 members returned their ballots, of whom 12 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

R. L. Sanford,
Chairman.

A. V. de Forest,
Secretary.

REPORT OF COMMITTEE A-10
ON
IRON-CHROMIUM, IRON-CHROMIUM-NICKEL AND RELATED ALLOYS

Since Committee A-10 was organized as recently as March of this year, it is not possible to give more than a brief progress report. The committee, for the most part, has been concerned with matters of organization. At the present time this organization is still temporary. There have been four sub-committees appointed: Sub-Committee I, to deal with the revisions of tabular matter on highly alloyed steels and related alloys, presented in connection with the Symposium on Corrosion-Resistant, Heat-Resistant and Electrical-Resistance Alloys held in 1924;[1] Sub-Committee II, to deal with the chemical analysis of these materials; Sub-Committee III, to deal with the problem of nomenclature, which is fairly well established—in some cases in erroneous directions by common practice—and Sub-Committee IV, to deal with methods of testing.

Sub-Committees II and IV have already held meetings and have their work well under way. Sub-Committees I and III have not yet held meetings, but are carrying on preliminary work through correspondence so as to reduce the time of the meetings and permit them to meet when other societies meet, in order to accomplish their purpose in a minimum time.

An attempt has been made to start bibliographic work covering the manufacture, uses and properties of the alloys falling under the jurisdiction of the committee and, in order to make the scheme as simple as possible, it has been determined to divide the work between the seven members of the Advisory Committee, each taking a group of publications with which he normally deals in his day's work, and reporting that at the Advisory Committee meetings. It may be possible to assemble this later into publishable form, available for general use.

Committee A-10 started with a membership of 34 at the organization meeting. This has since grown to 42, of which 16 are producers, 20 are consumers and 6 are classed as general interests. The committee is at present discussing a question of jurisdiction of the field to be covered, particularly concerning the division of high-temperature activities between it and Committee B-4 on High-Temperature and Electrical-Resistance Alloys. It is hoped that within the next month or two a decision will have been reached so that both committees may actively proceed without duplication. Essentially, Committee A-10 at the present time is a fact-finding and research group, with its possible specification activity somewhat in the background; this will likely not develop for a year or two.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part II, p. 189 (1924).

Respectfully submitted on behalf of the committee.

JEROME STRAUSS,
Chairman.

N. L. MOCHEL,
Secretary.

REPORT OF RESEARCH COMMITTEE ON THE EFFECT OF TIN AND ARSENIC ON HIGH-SPEED TOOL STEEL

Reliable investigators have found that certain percentages of arsenic and tin in steel are detrimental. Due to the fact that much of the tungsten ore to-day contains considerable percentages of arsenic and tin and since the supplies of desirable ores are rapidly diminishing, it was desired to determine the amounts of these metals which could be alloyed with steel and not prove detrimental. The Executive Committee of the Society, acting upon the recommendation of Committee E-9 on Correlation of Research and with the approval of Committee A-9 on Ferro-Alloys, in April, 1925, authorized the formation of a Research Committee on the Effect of Tin and Arsenic on High-Speed Tool Steel. The committee as originally formed consisted of N. B. Hoffman, Metallurgist, Colonial Steel Co., Pittsburgh, Pa., chairman; A. E. White, University of Michigan, Ann Arbor, Mich.; G. E. F. Lundell, U. S. Bureau of Standards, Washington, D. C.; J. V. Emmons, Metallurgist, Cleveland Twist Drill Co., Cleveland, Ohio; J. H. McCadie, Metallurgist National Twist Drill and Tool Co., Detroit, Mich. A few months after the formation of the committee, Mr. A. E. White found that he could not spare the necessary time to give to the work and resigned from the committee.

The committee is indebted to Mr. Frank L. Hess, Geologist, U. S. Department of Interior, and Mr. Charles Hardy of the Associated Metals and Minerals Corporation, New York City, for the following data showing the minimum and maximum percentages of tungstic oxide (WO_3) and arsenic and tin in the ores found in the various countries of the world.

	Tungsten Oxide, per cent	Arsenic, per cent	Tin, per cent
Argentina, Scheelite	71.90	trace	trace
Bolivia, Scheelite	67.41 to 74.49	trace	0.72 to 1.87
Bolivia, Ferberite	71.04 to 72.01	trace	trace
Bolivia, Wolframite	61.49 to 72.48	trace to 3.68	trace to 1.06
Burma, Scheelite	70.29	trace	1.21
California, Scheelite	63.72	trace	trace
China, Wolframite	62.00 to 73.00	0.06 to 0.087	trace to 3.96
England, Wolframite	51.00 to 57.00	2.39 to 3.82	2.00 to 7.00
Japan, Wolframite	69.93	2.38	0.47
Japan, Scheelite	61.21 to 69.93	trace	1.73 to 2.39
Korea, Scheelite	62.30 to 71.04	....	trace to 2.08

The average Chinese ore does not show an excess of arsenic, the arsenic contents of a few lots of Chinese ore being as follows: 0.09, 0.13, 0.07, 0.05, 0.04, 0.22, 0.15, and 0.20 per cent.

There is only one Chinese property in the Chaling district where the arsenic contents have run as high as 3 per cent. The average ores from all other parts do not show much arsenic. The Scheelite found in the Montana district and in California shows an arsenic content of from 2 to 3 per cent.

From the data given in the table above it is shown that some of the present foreign and domestic tungsten ores contain considerable amounts of arsenic and tin. It is also true that no new desirable ore bodies are being discovered.

INVESTIGATIONS PLANNED

It was the thought of the committee to prepare heats of high-speed steel containing arsenic and tin in the following amounts: 0.05, 0.10, 0.15, 0.20, 0.25 and 0.50 per cent, respectively, and to study the effect of the arsenic and tin. It was impossible, however, owing to the lack of time, to carry out the complete program, so it was decided to determine the properties of one regular composition high-speed steel containing 0.50 per cent of arsenic and one containing 0.50 per cent of tin. It was the opinion of the committee that this amount would show definite detrimental results in service.

The tests and results reported herein are in respect to these two types of steel only.

COMPOSITION OF TEST STEELS

The two compositions referred to were melted in one of the crucible furnaces of the Colonial Steel Co., Monaca, Pa. The base of the charge was high-grade muck bar. The vanadium, tungsten and chromium were added to the charge as ferro-alloys and the arsenic and tin were added in the form of arsenic metal and shot tin. The final analyses of the two steels was as follow:

	HIGH-TIN HEAT	HIGH-ARSENIC HEAT
Carbon, per cent	0.67	0.65
Manganese, per cent	0.24	0.21
Phosphorus, per cent	0.016	0.015
Sulfur, per cent	0.02	0.019
Silicon, per cent	0.10	0.12
Vanadium, per cent	0.93	0.96
Tungsten, per cent	17.15	17.57
Chromium, per cent	3.75	3.80
Tin, per cent	0.445	trace
Arsenic, per cent	trace	0.51

PROCESSING OF THE STEEL

The steel from the above two heats were cast into 4-in. square ingots. They were heated to 2150° F. and hammer cogged to billets 2 in. square. In cogging the arsenic ingot, a heavy fog and fumes of arsenic were given off. This condition was only slightly noticeable in cogging the tin ingot.

Both the arsenic and tin ingots did not flow as readily under the hammer as does a steel of this type without the addition of these elements.

The 2-in. hammer-cogged billets from both heats were then pickled in sulfuric acid to remove the scale or oxides. The billets were then thoroughly ground to remove the slightest surface defects.

These billets were then heated to 2150° F. and rolled to bars $1\frac{1}{16}$ in. in diameter. The rolled bars were annealed by heating to 1600° F., holding them at this temperature for three hours and cooling in the furnace.

The Brinell hardness on the two steels after annealing was as follows:

HIGH-ARSENIC STEEL	HIGH-TIN STEEL
238	250

This hardness compares favorably with that obtained on high-speed steel of regular composition when annealed.

BRITTLENESS IN ANNEALED CONDITION

That the amounts of contained arsenic and tin in these steels enhanced their brittleness was seen from the fact that a bar 2 ft. long, $1\frac{1}{16}$ in. round from each of the two types of annealed steel broke in a number of pieces when dropped on a concrete floor from a height of 4 ft.

CUTTING AND DRILLING TESTS

Bars of the $1\frac{1}{16}$-in. round stock of both types of steel were sent for test purposes to Mr. J. V. Emmons, Metallurgist, Cleveland Twist Drill Co., and 2-in. square bars to Mr. J. H. McCadie, Metallurgist, National Twist Drill and Tool Co.

Twist drills made from these steels, when given the usual treatment and service drilling tests, according to Mr. Emmons, were so brittle as to be worthless for the manufacture of twist drills. These steels broke readily in service due to their extremely low torsional strength. Mr. Emmons also advises that both steels were capable of withstanding a higher drawing temperature than is customary with ordinary high-speed steels of this class.

Mr. McCadie submitted the following report relative to the test conducted on the 2-in. bars:

Six 4 by ½ by 1-in. side milling cutters were made from the steel furnished by Mr. Hoffman. Three were made from the steel containing tin (these were marked 1140 –1, 1140 –2, and 1140 –3), and three were made from the steel containing arsenic (these were marked 1141 –1, 1141 –2, and 1141 –3).

Our regular practice was followed in forging. The proper lengths were sawed off, then upset to approximately 4¼ in. diameter and ⅝ in. thick. The forging was done at as near 2200° F. as possible. The blanks were cooled in lime after forging. The next operation was annealing at 1600° F. for three hours and cooling in the furnace. The Brinell hardness after annealing was 241 and 248.

Nothing unusual was noted in either the forging or machining of the cutters. The machined cutters were hardened by preheating to 1700° F. then raising quickly in the high-heat furnace to 2350° F. and quenching in oil. After cooling the cutters were drawn for one-half hour in a salt bath at 1125° F. The Rockwell hardness after hardening and tempering was from 62 to 64.

The cutting tests were made in a No. 2 Cincinnati Milling Machine. The spindle speed was 67 r.p.m. which gave a surface speed of 70 ft. per minute. The table feed was 8½ in. per minute.

The material cut was S.A.E. No. 3245 chromium-nickel steel heat treated to give a Brinell reading of 241. The test blocks were 6 by 2 by 17 in. long, the cuts being taken lengthwise of the block. Each cut was ¼ in. deep, ¼ in. wide and 17 in. long, only one-half the width of the cutter being used.

Two cutters were placed on the arbor at the same time. They were spaced 2½ in. apart, so that the work could be placed between them and alternate cuts be taken without changing the set-up of the machine. One of the cutters was made from our standard high-speed steel of the following approximate analysis:

Carbon, per cent	0.68
Manganese, per cent	0.25
Silicon, per cent	0.25
Vanadium, per cent	1.00
Tungsten, per cent	18.00
Chromium, per cent	3.75

These cutters were made and hardened as near like the test cutters as possible.

High-Tin Steel:

First Run.—After eighteen ½-in. cuts, cutter 1140 – 1 was too dull to continue. Stock – 1 made twenty cuts and was still in fair condition.

First Resharpening.—After eight cuts cutter 1140 – 1 was so dull that on tooth was broken. Stock – 1 completed the twenty cuts.

Second Run.—Cutter 1140 – 2 was dulled in making fifteen cuts. Stock – 2 went the twenty cuts.

First Resharpening.—Cutter 1140 – 2 was dulled in making seventeen cuts. Stock – 2 went twenty cuts.

High-Arsenic Steel:

First Run.—Both stock cutter No. 3 and cutter 1141 - 1 made the twenty cuts, but cutter 1141 - 1 was much duller than the stock cutter.

First Resharpening.—Both cutters again made the twenty cuts but cutter 1141 - 1 was much duller.

Second Run.—Cutter 1141 - 2 was dulled in making seventeen cuts. Stock - 4 made twenty cuts.

First Resharpening.—Cutter 1141 - 2 was dulled in making eighteen cuts. Stock - 4 made the twenty cuts.

SUMMARY

As has been previously stated, the intentions of the committee were primarily to test steels containing amounts of arsenic and tin sufficiently high to definitely show detrimental results in service tests. With detrimental effect of arsenic and tin in certain amounts determined, the committee will now test steels containing smaller amounts of arsenic and tin in order to determine the maximum safe allowable amounts of these two constituents.

CONCLUSIONS

The conclusions drawn are for the two types of steels included in this particular investigation and are as follows:

1. Arsenic and tin in amounts of 0.50 per cent in high-speed steel noticeably embrittles the steel.
2. The hardness of the annealed steel is comparable to that of the regular high-speed grade.
3. The red hardness cutting properties of these steels on cutting and drilling tests have been noticeably impaired by the addition of as much as 0.50 per cent of arsenic and 0.50 per cent of tin.
4. In respect to claims that have been made that losses of arsenic and tin in the melting process may run as high as 75 per cent, while this may be true in electric furnace melting, in the crucible melting of the two heats included in this investigation a loss was shown of only 28.8 per cent of tin and 18.4 per cent of arsenic.
5. The steels containing arsenic and tin did not flow as readily when hammer cogged as did the regular high-speed composition.

Respectfully submitted on behalf of the committee,

N. B. HOFFMAN,
Chairman.

REPORT OF RESEARCH COMMITTEE ON FATIGUE OF METALS

The Research Committee on Fatigue of Metals was formally organized at a meeting held December 12, 1928, at the Society's headquarters at Philadelphia. The membership of the committee is as follows:

H. F. Moore, chairman
H. W. Gillett
T. McL. Jasper
J. B. Kommers
J. M. Lessells
F. F. Lucas
D. J. McAdam, Jr.
R. R. Moore
R. L. Templin
J. R. Townsend
L. B. Tuckerman

At this organization meeting there were outlined three projects for the immediate attention of the committee.

1. The preparation each year of abstracts of the principal published material relating to the fatigue of metals.

2. The preparation of a statement of the present status of our knowledge as regards fatigue of metals.

3. A study of fatigue testing machines and specimens with a view to ascertaining whether the preparation of standards for such machines and specimens could be recommended to Committee E-1 on Methods of Testing or to other committees of the Society.

The carrying out of the projects under the first item was assigned to various members of the committee, as was the detailed work of preparing the statement as to the present knowledge of fatigue of metals. The third main project was assigned to a sub-committee consisting of Messrs. Jasper, McAdam and R. R. Moore. In addition to these specific projects, the committee planned to encourage the publication of experimental results, especially in the form of technical papers presented before the Society, and the general discussion of problems of fatigue of metals. It is hoped that later on the committee can be influential in stimulating definite researches in fatigue problems.

On March 20, 1929, the committee held a second meeting in Chicago, Ill., at which reports of progress were received from the subcommittee on specimens and machines and the members of the committee who were preparing abstracts of articles for the current year. Reports were also made on several articles on fatigue of metals to be submitted at the annual meeting of the Society.

In considering the presentation of a statement of the present knowledge of fatigue of metals, it was decided that such a presentation is not feasible this year but that the following statements might well be made at this time by the committee.

Nearly every investigator who begins the study of fatigue of metals is impressed with the ease and speed of making tests by applying a repeated high stress of some definite magnitude to specimens of different metals and noting the length of endurance of each metal. The committee wishes to point out that as a *measure of the ability of metals to withstand repeated working stresses* this method is utterly unreliable. Under severe overstress, the length of life of a material depends fully as much upon ductility as upon fatigue strength. If a series of metals were tested in this way and the metals listed in the order of length of endurance, this list would not, in general, show the arrangement of the same metals in order of fatigue strength under working stresses.

Of course for cases in which metal has to withstand very high repeated stresses in service, and is not expected to have an indefinitely long life, a comparison of endurance under stresses of the same order of magnitude as those which have to be withstood in service might give results of practical value.

There came before the committee the question of whether it should consider failure of metals by a flow under long-time steady loads as fatigue failure. The committee decided that for the present at least, it would consider a failure to be a fatigue failure only if it were one characterized by a spreading fracture in the metal.

Respectfully submitted on behalf of the committee,

H. F. MOORE,
Chairman.

REPORT OF SOCIETY REPRESENTATIVES ON THE JOINT RESEARCH COMMITTEE ON BOILER FEED WATER STUDIES

Through the Joint Research Committee on Boiler Feed Water Studies, six national technical organizations are cooperating actively in a study of the various processes employed in the purification of feed water in steam power plants and on railroads. This research is being carried on to determine the fundamental principles underlying certain phenomena which take place in steam boilers. The committee is sponsored by the American Boiler Manufacturing Association, the American Railway Engineering Association, the American Water Works Association, the National Electric Light Association, the American Society of Mechanical Engineers, and the American Society for Testing Materials, and has been sub-divided into nine technical committees and an advisory committee. Each technical committee is collecting data relating to the subject assigned it, and has been requested to compile and submit yearly reports. After these reports are reviewed by the Advisory Committee, they are presented for publication in the journals of the organizations participating in these studies.

The main technical committees include:

Technical Committee 1 on Sedimentation With and Without Chemicals; Pressure and Gravity Filters and Deconcentrators and Continuous Blowdown Apparatus.

Technical Committee 2 on Water Softening by Chemicals (External Treatment).

Technical Committee 3 on Foaming and Priming, Internal Treatment, and Behavior of Zeolite Softened Water.

Technical Committee 4 on Surface Condensers, Evaporators and Deaërators.

Technical Committee 5 on Corrosion of Boilers, and the Effect of Treated Water in Accelerating or Relieving These Troubles.

Technical Committee 6 on Embrittlement of Boiler Steel.

Technical Committee 7 on the Effect of Industrial Wastes on Boiler Feed Water Problems and Condenser Operation.

Technical Committee 8 on Standard Methods of Water Analysis.

Technical Committee 9 on Bibliography.

Since 1926, reports of the various technical committees have been presented at meetings of the American Society of Mechanical Engineers and of the American Water Works Association, and are printed in full in the yearly publications of these societies.

The scope of the activities contemplated is broad, involving an estimated expenditure of $60,000 per year for a 5-year period divided among Technical Committees 3, 4, 5, and 6. The required sum is being collected from the various national organizations and individuals, and active research work will be initiated when the required money is available.

Steam generating conditions in power plants have undergone such radical changes in recent years that the necessity for satisfactory water for these purposes has placed boiler feed water among important engineering materials. The American Society for Testing Materials, in cooperating in the activities of the Research Committee, considers water for any purpose as an engineering material, and hence is interested both in applications and in methods of tests for this material.

It will be observed from the list of technical committees that the effect of water on metals occupies a major part of the program. The studies by these committees are of particular value and interest to the Society's Committee A-5 on Corrosion of Iron and Steel and Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys.

A résumé of the more important subjects listed for investigation by this committee which are of significance to the corrosion committees of the American Society for Testing Materials include:

1. Study of boiler compounds for anti-corrosion.

2. Study of the causes of and methods for inhibiting corrosion in condenser tubes.

3. The value of electrolytic methods for the inhibition of corrosion and scale formation.

4. Determinations of the corrosion rate and hydrogen gas evolution in the absence of dissolved oxygen through the range of acidity and alkalinity in general practice and a temperature range from 140 to 450° F. (60 to 232° C.) on the heat transfer surfaces of the water cycle in steam plants. In this problem, the determinations should be made on distilled water and on water containing varied amounts of impurities.

5. In item 4, the corrosion rate will be determined, in addition to the dissolved oxygen present in amounts within the ranges usually found in practice. Investigation and development of field methods for determining very small amounts of oxygen in solution.

6. Determinations in the field of dissolved oxygen in locomotive and stationary boilers at various points in the circulating system. Boilers of various types included. The field tests on boilers will include some of the same type operating at various pressures.

7. Study of the variation in hydrogen-ion concentration, and alkalinity or acidity at boiler temperatures compared with these variables in the same water at normal temperature, 68° F. (20° C.). Investigation of the influence of high concentration of common salts on these variables at high temperatures.

8. Study in laboratory and field, the formation of protective films deposited from water on heating surfaces. The relation between dissolved oxygen, alkalinity, chlorides and protective scale formation will be investigated.

9. Study of pitting found under boiler scale, particularly in locomotives operating in certain geographical sections.

10. Electrolytic prevention—cause and effect.

11. Corrosion in boilers originating from organic materials.

12. Study action of inhibitors (organic and inorganic) at boiler temperatures.

13. Further studies on the effect of caustic solutions as an accelerator of embrittlement, especially at high temperatures and pressures.

14. The inhibiting or retarding effect of structure of metals on embrittlement.

15. The effect of phosphates, chlorides and other constituents in water in inhibiting or accelerating embrittlement.

16. The possibility of producing embrittlement under certain load conditions and with improperly treated boiler metal in the presence of water low in alkaline salts.

17. The effect of dissolved oxygen in accelerating the embrittlement of boiler steel.

18. The elimination of embrittlement of boiler steel by the use of forged drums in the presence of high caustic concentration in the boiler water.

19. The relation, if any, between corrosion and embrittlement.

20. Investigation of organic salts as an inhibitor of embrittlement.

Members of the Society who are investigating corrosion problems will find of especial interest the Proposed Method for Determination of Dissolved Oxygen in Boiler Feed Water, appended hereto. The method has been critically reviewed, and is complete with detailed instructions. It is applicable to many corrosion studies in which the dissolved oxygen determination is required.

Up to October 1, 1928, through the cooperation of the editorial staff of the American Society of Mechanical Engineers, 13 bibliographies containing 368 items have been issued containing items of interest to the various technical committees.

Respectfully submitted,

MAX HECHT,
F. N. SPELLER,
A.S.T.M Representatives,
Joint Research Committee
on Boiler Feed Water Studies.

APPENDIX

PROPOSED METHOD
FOR
DETERMINATION OF DISSOLVED OXYGEN IN BOILER FEED WATER

1. *Scope.*—The presence of dissolved oxygen in water used for boiler feed is objectionable, since it increases the corrosive properties of the water. It is essential in steam-station operation that the dissolved oxygen content of the feed water be kept as low as possible. In order to control the dissolved oxygen, tests should be made at frequent intervals.

2. *Application of Test.*—(*a*) The application of the Winkler method, herein described in detail, is intended for use on all boiler feed water supplies except raw water.

(*b*) After further investigation it may be possible to indicate the permissible amounts of organic matter, nitrites, or iron salts under which the method outlined may be employed.

(*c*) If organic matter, nitrites, or iron salts are present in appreciable amounts, the Rideal-Stewart method should be applied.[1]

Reagents Required

3. (*a*) *Manganous Chloride.*—Dissolve 425.5 g. of crystalline manganous chloride c.p. ($4H_2O$) in 1000 cc. of distilled water.

(*b*) *Alkaline Potassium Iodide.*—Dissolve separately 700 g. of potassium hydroxide c.p. and 150 g. of potassium iodide c.p. in distilled water and dilute the mixture to 1000 cc.

(*c*) *Sulfuric Acid.*—Mix carefully equal volumes of concentrated sulfuric acid (sp. gr. 1.84) and distilled water.

(*d*) *Starch Solution.*—Dissolve 5 g. of Litners soluble starch in 50 cc. of distilled water to make a thin paste and then pour into 200 cc. of boiling distilled water and continue boiling for 4 or 5 minutes. When cold, add a few drops of chloroform and keep this solution in a dark glass-stoppered bottle. Starch solution does not keep well and should be made up fresh every week.

(*e*) *Sodium Thiosulfate* (*0.025 N*).—Dissolve 6.205 g. of chemically pure recrystallized sodium thiosulfate in distilled water and dilute the solution to 1000 cc. with freshly boiled and cooled distilled water. Each cubic centimeter is equivalent to 0.2 mg. of oxygen or to 0.1395 cc. of oxygen at 0° C. and 760 mm. pressure. Inasmuch as this solution is not permanent it should be standardized every week against a 0.025 *N* solution of potassium dichromate or 0.025 *N* solution of potassium permanganate. If special investigations are being made the thiosulfate should be calibrated daily.

Note.—When facilities for the preparation of the above reagents are not available they may be purchased from any reliable chemical supply house.

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[1] "Standard Methods of Water Analysis," Am. Public Health Assn., sixth edition (1925).

Apparatus

4. *Apparatus.*—The illustrations in Figs. 1 to 5 show the apparatus and steps in the procedure. The copper-coil condenser shall conform to the construction details shown in Fig. 1.

Sampling

5. *Sampling.*—Water supplied in excess of 125° F. and above atmospheric pressure shall be cooled to room temperature through a copper-coil condenser, throttled at the discharge end.

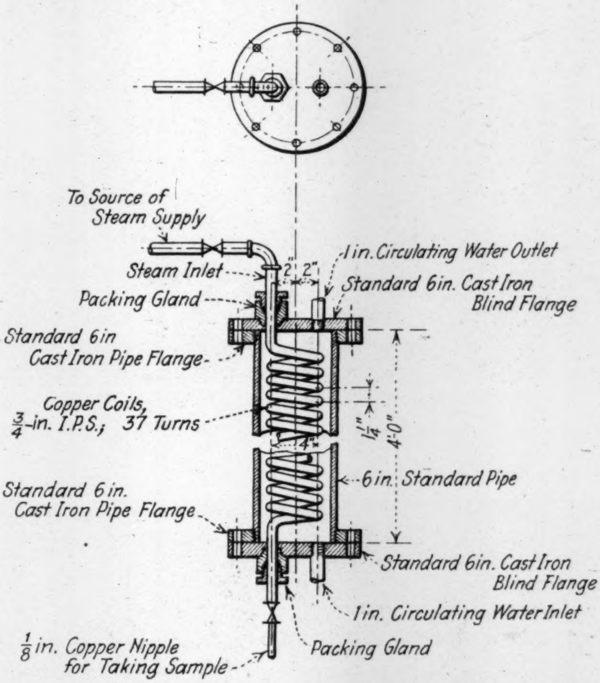
To Source of Steam Supply
Steam Inlet
Packing Gland
Standard 6 in Cast Iron Pipe Flange
Copper Coils, ¾-in. I.P.S.; 37 Turns
Standard 6 in. Cast Iron Pipe Flange
⅛ in. Copper Nipple for Taking Sample
1 in. Circulating Water Outlet
2" 2"
Standard 6 in. Cast Iron Blind Flange
1¼"
4'-0"
4"
6 in. Standard Pipe
Standard 6 in. Cast Iron Blind Flange
1 in. Circulating Water Inlet
Packing Gland

Fig. 1.—Sketch of Cooling Coil for Dissolved Oxygen Test.

A narrow-necked glass-stoppered bottle of 250 to 300-cc. capacity is satisfactory for collecting the sample. To the end of the sample connection of the cooling coil a glass tube shall be attached by means of heavy-walled rubber hose, ¼-in. bore, ⅛-in. wall, so as to permit filling the bottle by displacement of the air and water by overflowing. The minimum rate of filling shall be 250 cc. per 30 seconds and the sample bottle shall be permitted to overflow not less than 5 minutes. This procedure insures the complete removal of air in the bottle and prevents subsequent solution in the water of such air. Make certain that the sample line from the source of sampling to the bottle has been freed of air bubbles and deposits by a strong flushing of the line. After the water has been displaced in the specified time, the glass tube shall be removed and the glass stopper quickly inserted in place to prevent exposure of the sample

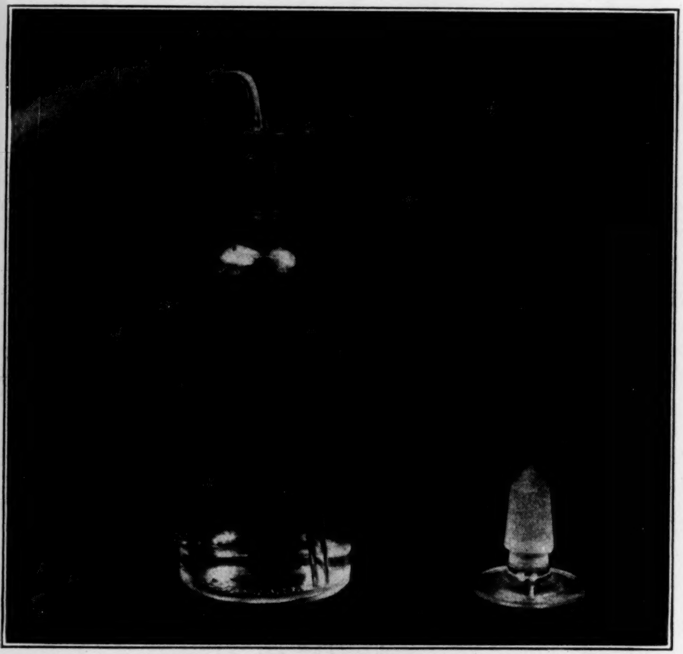

FIG. 2.—Set-up of Bottle for Collecting Water Samples, Showing Stopper Ground to Point.

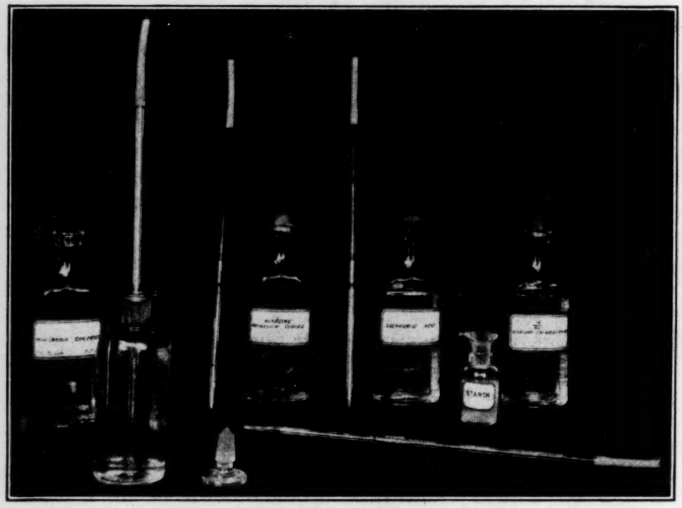

FIG. 3.—Sample of Water Before Treatment with Reagents to Fix Dissolved Oxygen, Showing Pipettes for Reagent Additions.

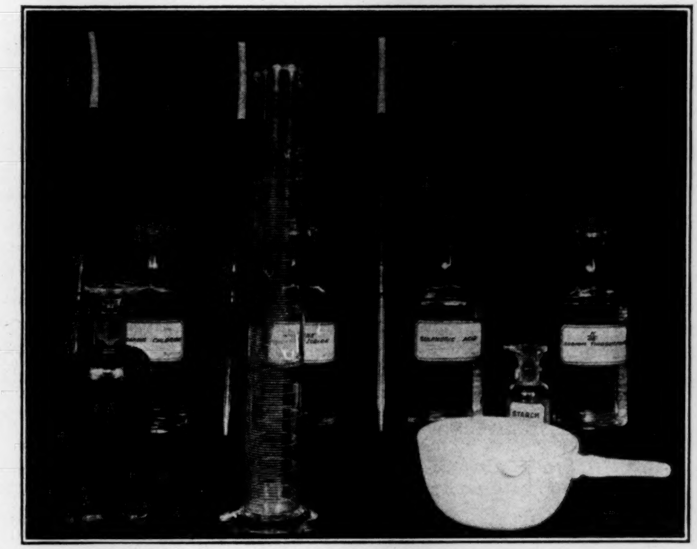

FIG. 4.—Sample of Water After Reagents Have Been Added to Fix Dissolved Oxygen and Apparatus After Measuring Out Necessary Volume for the Test.

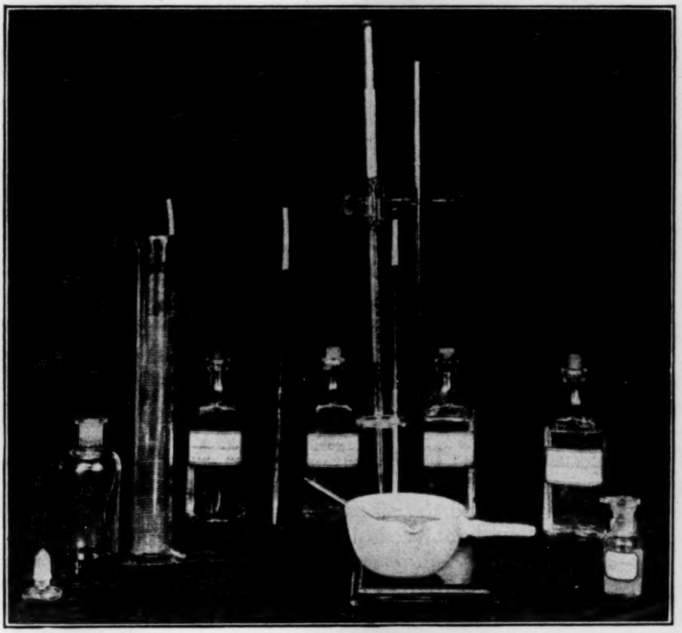

FIG. 5.—Sample Transferred to Casserole, Showing Apparatus After Addition of Reagent to Estimate Dissolved Oxygen.

to the air. Make certain that no air space is left between the stopper and water sample. Mushroom glass stoppers ground to a point or cone to eliminate trapping of air shall be used.

The next step of adding the reagents as described in Section 7 (*a*) should proceed immediately.

PROCEDURE

6. *Winkler Method.*—The Winkler iodimetric method depends upon the liberation in the solution of an amount of iodine exactly proportional to the amount of oxygen dissolved. Chemically, it amounts to the oxidation of the manganous-chloride solution to manganic acid by the oxygen present, and a subsequent reduction of iodide by the manganic acid. The starch indicator indicates the presence of iodine, and the standardized solution of sodium thiosulfate has a definite iodine absorbing value. The calculations by the formula are in terms of oxygen, but the intermediate steps are computed in terms of iodine.

The chemical reactions involved are as follows:

(1) $MnCl_2$	$+2\ KOH$	=	$Mn(OH)_2$	$+2\ KCl$
manganous chloride	+potassium hydroxide		manganous hydroxide	+potassium chloride
(2) $2\ Mn(OH)_2$	$+O_2$	=	$2\ H_2MnO_3$	
manganous hydroxide	+oxygen		manganous acid	
(3) $2\ KCl$	$+H_2SO_4$	=	K_2SO_4	$+2\ HCl$
potassium chloride	+sulfuric acid		potassium sulfate	+hydrochloric acid
(4) $Mn(OH)_2$	$+H_2SO_4$	=	$MnSO_4$	$+2\ H_2O$
manganous hydroxide	+sulfuric acid		manganous sulfate	+water
(5) H_2MnO_3	$+4\ HCl$	=	$MnCl_2$	$+3\ H_2O + Cl_2$
manganous acid	+hydrochloric acid		manganous chloride	+water +chlorine
(6) $2\ KI$	$+Cl_2$	=	$2\ KCl$	$+I_2$
potassium iodide	+chlorine		potassium chloride	+iodine
(7) $2\ Na_2S_2O_3$	$+I_2$	=	$Na_2S_4O_6$	$+2\ NaI$
sodium thiosulfate	+iodine		sodium tetrathionate	+sodium iodide

7. (*a*) *Procedure.*—Remove the stopper from the sample bottle and add immediately 2 cc. of manganous chloride and 2 cc. of alkaline potassium iodide in the order mentioned and quickly replace the stopper. The pipettes used to deliver these reagents should extend to the bottom of the bottle and the additions made in sequence with individual pipettes should be rapid. A short length of rubber tubing shall be attached to the upper end of the pipettes to reduce the possibility of drawing the solution into the mouth. Do not expel solution by breath.

After the addition of the alkaline potassium iodide, replace the stopper, mix by shaking, and *permit the precipitate to settle* (see Note 1). Then add 2 cc. of sulfuric acid and mix by shaking (see Note 2).

The procedure to this point must be carried out in the field, but after the acid has been added and the stopper replaced the test shall be completed as soon as convenient, preferably within 1 hour.

(*b*) *Titrating the Sample.*—Measure 250 cc. of the sample and transfer to a 300-cc. porcelain casserole No. 4 size. (The entire sample may be conveniently transferred and titrated if the volumes of the sample bottles are previously determined.)

Titrate the sample with 0.025 *N* sodium thiosulfate until the solution becomes a pale yellow color, then add 3 cc. of the starch solution and titrate until the first disappearance of the blue color.

If the sample contains oxygen in excess of 0.5 cc. per liter the water will have a decided yellow color.

If the sample contains zero oxygen or only traces of oxygen, the water will not appear yellow. The starch solution should then be added and if any blue color appears thiosulfate should be added until the blue color disappears. The difference between the initial and final readings of the burette will be the number of cubic centimeters of thiosulfate used, which is proportional to the amount of oxygen present.

NOTES

NOTE 1.—When the manganous chloride and alkaline potassium iodide are added a white precipitate will be noticed (manganese hydroxide).

If oxygen is present a brown-colored precipitate will be noticed which is manganous acid depending upon the amount of oxygen present.

NOTE 2.—The addition of the sulfuric acid dissolves the brown precipitate and sets free an amount of iodine equivalent to the quantity of oxygen in the sample.

The solution at this time will be yellow in color; the depth of color depending upon the amount of oxygen present.

If oxygen is present and starch is added to the solution at this stage the color will change to a deep green or blue color depending upon the amount of iodine (oxygen) present.

CALCULATIONS

8. *Calculations.*—If 250 cc. of water were titrated the calculations will be as follows:

$$\begin{array}{l}\text{cubic centimeters of oxygen per liter}\\ \text{standard condition (0° C. and 760 mm.)}\end{array} = \frac{1000}{250} \times \begin{array}{l}\text{(cubic centimeters of 0.025 } N\\ \text{thiosulfate} \times 0.1395)\end{array}$$

Individual results shall be expressed to the nearest 0.01 cc. Determinations below 0.03 cc. shall be reported as "trace."

9. *Accuracy.*—With care, the above procedure will give reproducible results as low as 0.03 cc. of oxygen per liter.

REPORT OF COMMITTEE B-1
ON
COPPER WIRE

Since the last annual meeting, Committee B-1 has held **one** meeting, at Chicago, Ill., on March 20.

Committee B-1 has but two matters actively before it. As announced in 1927[1] a sub-committee has been organized to consider the matter of specifications for wire and cable for electric power transmission lines, which subject is before Committee B-1 in its capacity as a sectional committee organized under the procedure of the American Standards Association. This sub-committee is actively at work but has not progressed to a point where a report is possible.

So far as the work on trolley wire with the American Electric Railway Association is concerned, the acceptance of the Tentative Specifications for Bronze Trolley Wire (B 9 – 27 T)[2] practically brought matters to a conclusion. These specifications have been formally adopted by the A.E.R.A. and no criticisms of them have been received by Committee B-1. The committee accordingly recommends that Specifications B 9 – 27 T be adopted by the Society as standard.

At the request of the National Electric Manufacturers' Association, Committee B-1 has undertaken cooperatively with the N.E.M.A. and the American Mining Congress, the development of specifications for grooved trolley wire for use in mines. This work is going forward in the hands of the same committee which has handled the matter of trolley wire for railway service, with the addition of representatives of the N.E.M.A. and the American Mining Congress. Progress is being made but no report is yet possible.

The recommendation appearing in this report has been submitted to letter ballot of the committee, with the following result:

Item	Affirmative	Negative	Not Voting
I. ADVANCEMENT OF TENTATIVE STANDARD TO STANDARD			
Tentative Specifications for Bronze Trolley Wire (B 9 – 27 T)........................	14	0	2

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 266 (1927).

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 709 (1927); also **1928 Book of A.S.T.M. Tentative Standards, p. 142.**

This report has been submitted to letter ballot of the committee, which consists of 19 members; 16 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

J. A. CAPP,
Chairman.

EDITORIAL NOTE

The Tentative Specifications for Bronze Trolley Wire were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 90.

REPORT OF COMMITTEE B-2
ON
NON-FERROUS METALS AND ALLOYS

During the past year, Committee B-2 has gone through a period of reorganization. The advisory committee has considered many matters in connection with the transfer of activities of its former Sub-Committees II, III, IV, VI and VIII to the new standing Committees B-5, B-6 and B-7. Sub-Committee XV on Die-Cast Metals and Alloys has prosecuted very vigorously its extensive research program into the properties of die-cast alloys. Sub-Committee VII on Methods of Chemical Analysis is investigating analytical methods for manganese bronze, silver solders, zinc-base die castings, and cadmium in zinc.

No recommendations for changes in the standards or tentative standards are being made.

REORGANIZATION ACTIVITIES

For a number of years the sum total of the activities of the sub-committees of Committee B-2 has been continuously growing. According to the By-laws of the Society, a large volume of matter from these sub-committees necessarily had to pass through Committee B-2, and this volume had grown too great to be handled by the officers of the committee. Consequently, the advisory committee of Committee B-2 as far back as 1925 gave serious thought to methods whereby the sub-committees might become autonomous, or whereby the main office of the Society could assume some of the duties devolving upon the officers of the standing committees. Definite recommendations along these lines were made to the Executive Committee of the Society in 1927.

Committee B-2 for many years has had direct jurisdiction over all the Society's standardization work in the non-ferrous metals field (except that in copper wire in charge of Committee B-1). Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys was organized in 1922 to handle corrosion problems, and Committee B-4 in 1925 was organized to consider high-temperature and electrical-resistance alloys. Since it was generally agreed that certain other activities in the field of copper alloys and aluminum alloys had now reached a stage of development where it would be logical to have them handled by separate standing committees, such reorganization was decided upon. Sub-Committees II and III, on Wrought Metals and Alloys and on Sand-Cast Metals and Alloys, respectively have been merged into a new standing Committee B-5 on Copper and Copper Alloys, Cast and Wrought. Sub-Committee VIII on Light Metals and Alloys has also been reconstituted into Committee B-7 on Light Metals and Alloys, Cast and Wrought.

Sub-Committee IV on White Metals—Tin, Lead and Zinc is being reorganized as a new Committee B-6 on Alloys of Tin, Lead, Zinc and Antimony.

The most important feature of this new set-up in committee organization in the non-ferrous metals field, and the only innovation from the administrative point of view, is the formation of a Coordinating Committee on Non-Ferrous Metals and Alloys. In the beginning it will be made up of two representatives designated by each of the committees in the non-ferrous metals group. One of its most important functions will be to coordinate the activities of the non-ferrous metals committees, adjusting questions of scope and jurisdiction, taking care of possible overlaps in committee activities and providing for joint activities where necessary. It will, therefore, assume some of the duties formerly devolving upon the Advisory Committee of Committee B-2, although the latter in the future, as in the past, will have the principal labor of fostering new activities in the non-ferrous field by appropriate Sub-Committees of Committee B-2. Messrs. P. D. Merica and W. H. Bassett have been named to represent Committee B-2 on this new coordinating committee.

ACTIVITIES OF SUB-COMMITTEES

Sub-Committee I on Pure Metals in Ingot Form (W. H. Bassett, chairman).—This sub-committee last year developed the Tentative Specifications for Fire-Refined Copper Other than Lake (B 72 – 28 T). While no criticisms of these specifications have come to the committee's attention, it is believed desirable to continue them as tentative for another year.

The sub-committee also takes cognizance of the fact that an increasing volume of electrolytic zinc is now on the market and the trade practices between zinc producers and brass manufacturers, galvanizers and consumers generally are in a state of flux. Consideration is being given of the propriety of revising the Standard Specifications for Slab Zinc (Spelter) (B 6 – 18) so that they may properly cover the present field.

Sub-Committee II on Wrought-Metals and Alloys (W. Reuben Webster, chairman) and *Sub-Committee III on Sand-Cast Metals and Alloys* (N. K. B. Patch, chairman).—These sub-committees have been merged to form the new Committee B-5 on Copper and Copper Alloys, Cast and Wrought.

Sub-Committee IV on White Metals—Tin, Lead and Zinc (G. H. Clamer, chairman).—This sub-committee is being reorganized to form the new Committee B-6 on Alloys of Tin, Lead, Zinc and Antimony.

Sub-Committee VII on Methods of Chemical Analysis (H. A. Bedworth, chairman).—This sub-committee held two formal meetings during the year. It was decided to continue the Tentative Methods of Chemical Analysis of Aluminum and Light Aluminum Alloys (B 40 – 28 T) as tentative until these methods could be adequately discussed with the personnel of the newly organized Committee B-7 on Light Metals and Alloys, Cast and Wrought.

Study of the Standard Methods of Chemical Analysis of Manganese Bronze (B 27 – 19) was continued during the past year. It is anticipated that a decided improvement can be made in the persulfate method described in the tentative revision recommended in 1928.[1] Meanwhile, it is recommended that the latter be continued as tentative.

With the help of Sub-Committee XIV On Silver and Gold Solders, the sub-committee has secured samples of three typical silver solders, made in accordance with the Tentative Specifications for Silver Solders (B 73 – 28 T) and various members have made analyses to determine suitable and accurate methods. A preliminary draft of methods has been made and discussed.

Work has also been started on methods of analysis for zinc-base die-casting alloys. A joint meeting was held with Sub-Committee XV to discuss this matter.

Sub-Committee VIII on Light Metals and Alloys (E. Blough, chairman).—This sub-committee has been discontinued, the work having been assumed by the new Committee B-7 on Light Metals and Alloys, Cast and Wrought.

Sub-Committee IX on Nomenclature of Metals and Alloys (E. E. Thum, chairman).—This sub-committee held one meeting in which definitions for brass and bronze were discussed, and several alternative terms for "german silver" considered. Trade practices are so various, and works' jargon is so well intrenched, that it appears doubtful whether a logical nomenclature would find general favor.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1120 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 852.

Sub-Committee XV on Die-Cast Metals and Alloys (H. A. Anderson, chairman).—This sub-committee has made considerable progress during the past year in the very comphrehensive series of cooperative tests on the aluminum-base and zinc-base die-cast alloys. The determinations of the physical properties and chemical compositions of the 12 aluminum-base die-cast alloys are practically completed and the zinc-base alloys have all been distributed and the test work on these alloys is about half finished. In addition to the chemical and physical tests certain other studies were made by outstanding authorities for the sub-committee. The detailed report of the sub-committee is appended hereto. This report includes a statistical analysis of the test data by W. A. Shewhart; metallographic studies of the aluminum-base die castings, by E. H. Dix, Jr. and J. F. Keller; X-ray inspection of the die castings, by Ancel St. John and a summary of the die-casting progress in Europe by E. V. Pannell.

This report has been submitted to letter ballot of the committee, which consists of 115 members; 78 members returned their ballots, of whom 77 have voted affirmatively and none negatively and one failed to vote.

Respectfully submitted on behalf of the committee,

WILLIAM CAMPBELL,
Chairman.

E. E. THUM,
Secretary.

ADDENDUM TO REPORT OF COMMITTEE B-2

At the meeting of Committee B-2 held in Atlantic City on June 27, 1929, action was taken to recommend that the Tentative Specifications for Rolled Zinc (B 69 – 27 T) be advanced to standard without revision and the Tentative Specifications for Silver Solders (B 73 – 28 T) be revised as follows and advanced to standard:

Section 8.—Change the third, fourth and fifth sentences to read as follows by the addition of the italicized words and the omission of the words in brackets:

> Samples from wire, sheet or strip shall be taken by shearing or clipping pieces from the entire cross-section of the same, remelting in a clean container at a temperature slightly above the melting range, mixing thoroughly, and pouring into a cold mold of convenient size for milling, [or] drilling *or sawing.* The sample so prepared shall be milled, [or] drilled *or sawed* in such a manner as to represent the entire cross-section. [All samples shall be clean and free from dirt, oil, oxide or other foreign material.] *The saw, drill, cutter or other tool used shall be thoroughly cleaned. No lubricant shall be used in the operation, and the sawings or metal chips shall be carefully treated with a magnet to remove any particles of steel introduced in taking the sample.*

Section 9.—Change from its present form: namely,

> 9. In the case of dissatisfaction, the solder shall be sampled in the presence of representatives of both the manufacturer and the purchaser. The thoroughly mixed sample shall be divided into three equal parts, each of which shall be placed in a sealed package, one for the manufacturer, one for the purchaser, and one for an umpire, if necessary.

to read as follows:

> 9. In the case of disagreement, the solder shall be re-sampled in the presence of the manufacturer and purchaser. The sample shall consist of not less than 3 oz. of solder prepared as described in Section 8. The thoroughly mixed sample shall be divided into three equal parts, each of which shall be placed in a sealed package, one for the manufacturer, one for the purchaser, and one for an umpire, if necessary.

Section 12.—Change this section to read as follows by the addition of the italicized words:

> 12. All wire, sheet and strip shall be *reasonably* smooth and bright and *substantially* free from slivers, splitting, or other injurious or objectional defects.

Section 13.—Change this section to read as follows by the addition of the italicized words:

> 13. Granular solder shall be *substantially* free from oxide, dirt, or any foreign material which will impair its working qualities.

The committee accordingly makes these recommendations for advancement to standard of these two tentative specifications, subject to the approval by subsequent letter ballot vote of the committee.[1]

Respectfully submitted,

WILLIAM CAMPBELL,
Chairman.

E. E. THUM,
Secretary.

EDITORIAL NOTE

The Tentative Specifications for Silver Solders and Specifications for Rolled Zinc were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 113 and 76, respectively.

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[1] The letter ballot on this recommendation resulted as follows: Tentative Specifications for Rolled Zinc, 64 affirmatively and none negatively with 20 members not voting; Tentative Specifications for Silver Solders, 61 affirmatively, none negatively, with 23 members not voting.—ED.

REPORT OF SUB-COMMITTEE XV ON DIE-CAST METALS AND ALLOYS

This sub-committee's investigation of die-casting alloys involves the casting and testing of 80,000 die-cast test specimens. It consists of four main phases, as follows:

1. Tests of 12 aluminum-base alloys in the form of die-cast specimens from various producers.
2. Tests of 9 zinc-base alloys in the form of die-cast specimens from various producers.
3. Corrosion studies of these aluminum-base and zinc-base alloys.
4. Analysis of the test data and preparation of specifications.

The first phase is now complete with accumulated test data from over 20,000 aluminum-base alloy specimens. The zinc-base alloy specimens have all been prepared and distributed, and the test work is over half completed on this second phase of the investigation. The third phase contemplates atmospheric exposure of 35,000 aluminum-base and zinc-base alloy specimens and measurements of changes in weight and strength at one, three, and five-year periods. The specimens for corrosion studies were placed in May and June of this year on test racks at 10 scattered locations. The exposure program is being planned and financed in conjunction with Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. The fourth phase will comprise the preparation of specifications based upon the foregoing studies.

Initial Physical and Chemical Studies:

The initial work of the sub-committee consisted in determining the chemical compositions and physical properties of the die-cast specimens as supplied by the cooperating producers. The standard procedure agreed upon for the casting and testing of the specimens was outlined in the 1928 Report.[1]

Five producers made die-castings of the 12 aluminum-base alloys and shipped lots of specimens to eight cooperating laboratories and to the U. S. Bureau of Standards. Specimens were cast to certain specified compositions, shown in Table I, and in accordance with the standard sizes and shapes shown in Fig. 1 of the 1928 Report.[2] Physical tests were carried out in accordance with the standard testing procedure described in Appendix III to the 1928 Report[1] and reported on the test record form shown with the procedure. Summaries of all test results reported by each cooperating laboratory were circulated as received to all of the approximately 50 members of the sub-committee, so that the information was made available to the interested parties as promptly as possible.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 202 (1928).

[2] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 203 (1928).

TABLE I.—LIST OF ALLOYS AGREED ON FOR DIE-CASTING INVESTIGATION WITH NOMINAL COMPOSITIONS DESIRED.

ALUMINUM-BASE ALLOYS[2]

Alloy[a]	Copper, per cent	Silicon, per cent	Nickel, per cent	Iron, per cent	Aluminum, per cent
No. I	4	....	....	1.5 to 2	remainder (94)
No. II	10	....	....	1.5 to 2	remainder (88)
No. III	14	....	....	1.5 to 2	remainder (84)
No. IV	....	5	....	1.5 to 2	remainder (93)
No. V	....	13	....	1.5 to 2	remainder (85)
No. VI	2	3	....	1.5 to 2	remainder (93)
No. VII	4	5	....	1.5 to 2	remainder (89)
No. VIII	1.5	0.75	2.25	1.5 to 2	remainder (94)
No. IX	4	1.5	4	1.5 to 2	remainder (89)
No. X	....	2	5	1.5 to 2	remainder (91)
No. XI	2	8	....	1.5 to 2	remainder (88)
No. XII	8	1	....	1.5 to 2	remainder (89)

ZINC-BASE ALLOYS[2]

Alloy[a]	Copper, per cent	Aluminum, per cent	Magnesium, per cent	Tin, per cent	Zinc, per cent	Grade of Zinc Based on A.S.T.M. Specification B 6-18
No. XIII	5.0	0.25	....	....	remainder (94.75)	High Grade
No. XIV	3.0	4.0	....	....	remainder (93.0)	High Grade
No. XV	3.0	4.0	0.1	....	remainder (92.9)	High Grade
No. XVI	3.0	4.0	0.1	....	remainder (92.9)	Special High Grade[b]
No. XVII	3.0	3.0	0.3	....	remainder (93.7)	High Grade
No. XVIII	3.0	0.5	....	6.0	remainder (90.5)	Prime Western
No. XIX	2.0	4.0	0.1	....	remainder (93.8)[d]	Special High Grade[b]
No. XX	3.0	4.0	....	....	remainder (93.0)	Special Grade[c]
No. XXI	3.0	4.0	0.1	....	remainder (92.9)	Special High Grade[e]

[a] This identification number and the manufacturer's mark cast on each specimen.

[b] Special grade, lead and cadmium together, permissible maximum, 0.06 per cent; tin, none; zinc, minimum 99.94 per cent.

[c] Slab zinc analyzing at least 99.75 per cent zinc.

[d] Containing nickel 0.02 per cent in addition.

[e] Special grade, lead and cadmium together, permissible maximum, 0.01 per cent; tin, none; zinc, minimum 99.99 per cent.

Similar practice was followed in the case of the chemical analyses which were made by two or three laboratories for each producer's specimens. Remarkable agreement was found between the various laboratories' results on a given producer's product, indicating effectiveness of the testing procedure previously agreed upon, as well as the

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[1] *Proceedings*, Am. Soc. Testing Mats. Vol. 28, Part I, p. 213 (1928).

[2] The aluminum-base alloys should preferably be free from manganese and magnesium (permissible maximum on each, 0.05 per cent); the zinc-base alloys should be made of the specified or a higher grade of zinc, 99-per-cent aluminum, straits tin and electrolytic or lake copper.

TABLE II.—RESULTS OF CHEMICAL ANALYSES OF ALUMINUM-BASE DIE-CAST ALLOYS.

Alloy	Producer	Number of Analyses	Chemical Composition, Average of All Laboratory Analyses										
			Copper, per cent	Silicon, per cent	Nickel, per cent	Iron, per cent	Manganese, per cent	Magnesium, per cent	Zinc, per cent	Cadmium, per cent	Tin, per cent	Lead, per cent	Aluminum, per cent
No. I	nominal	..	4	....	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (94)
	A	3	4.37	0.43	Nil	1.48	0.01	0.03	0.05	Nil	Nil	....	93.63
	B	2	3.51	0.63	0.17	1.50	0.03	0.03	0.18	Nil	Nil	....	93.95
	C	3	3.97	0.32	0.03	2.77	0.02	0.01	Nil	Nil	0.08	....	92.80
	D	3	4.23	0.59	0.45	1.90	0.02	0.04	0.03	Nil	Nil	....	92.74
	E	2	3.80	0.31	Nil	2.35	0.03	Nil	0.08	Nil	Nil	....	93.43
No. II	nominal	..	10	....	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (88)
	A	3	7.13	0.38	Nil	1.96	0.01	0.04	0.16	Nil	Nil	....	90.32
	B	2	8.97	0.34	0.05	1.44	0.03	0.13	0.09	Nil	Nil	....	88.95
	C	3	9.36	0.31	Nil	1.71	0.02	Nil	Nil	Nil	Nil	....	88.60
	D	3	10.47	0.44	Nil	1.44	0.01	0.01	0.05	Nil	Nil	....	87.58
	E	2	8.93	0.44	Nil	3.07	0.03	Nil	0.20	Nil	Nil	....	87.33
No. III	nominal	..	14	....	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (84)
	A	3	11.99	0.43	0.14	1.76	0.02	0.03	0.09	Nil	Nil	....	85.54
	B	2	13.14	0.32	0.12	1.67	0.08	0.03	0.09	Nil	Nil	....	84.55
	C	3	14.29	0.27	Nil	1.72	0.02	0.01	0.03	Nil	Nil	....	83.66
	D	3	13.20	0.53	Nil	1.57	0.01	0.01	0.08	Nil	Nil	....	84.60
	E	2	13.02	0.37	Nil	2.74	0.03	0.02	0.11	Nil	Nil	....	83.71
No. IV	nominal	..	....	5	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (93)
	A	3	0.58	4.16	0.01	1.85	0.01	0.07	0.02	Nil	Nil	....	93.30
	B	2	0.34	5.07	Nil	1.48	0.07	0.06	0.44	Nil	Nil	....	92.54
	C	3	0.68	5.27	Nil	1.29	0.02	0.01	Nil	Nil	Nil	....	92.73
	D	3	0.24	5.11	0.22	1.89	0.04	0.01	0.11	Nil	Nil	....	92.38
	E	2	0.61	4.41	Nil	2.53	0.03	0.02	5.90	Nil	Nli	....	86.50
No. V	nominal	..	....	13	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (85)
	A	3	0.64	13.00	0.08	1.59	0.19	0.09	0.22	Nil	Nil	....	84.20
	B	2	0.98	12.96	0.03	1.52	0.09	0.12	0.90	Nil	Nil	....	83.40
	C	3	0.15	12.42	Nil	1.89	0.03	0.01	0.03	Nil	0.06	0.21	85.20
	D	3	0.05	12.97	0.02	1.35	0.02	0.03	0.06	Nil	Nil	....	85.50
	E	2	0.20	10.72	Nil	4.34	0.06	0.04	0.60	Nil	Nil	....	84.04
No. VI	nominal	..	2	3	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (93)
	A	3	1.91	2.96	0.35	1.30	0.66	0.05	0.42	Nil	Nil	....	92.35
	B	2	1.98	3.19	Nil	1.53	0.04	0.07	0.32	Nil	Nil	....	92.87
	C	3	2.06	3.23	Nil	1.98	0.03	0.01	0.01	Nil	Nil	Nil	92.68
	D	3	2.18	3.27	Nil	1.86	0.02	0.02	0.04	Nil	Nil	....	92.61
	E	2	2.16	5.02	Nil	3.38	0.06	0.01	0.16	Nil	Nil	....	89.21
No. VII	nominal	..	4	5	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (89)
	A	3	3.53	5.11	0.09	1.45	0.20	0.01	0.43	Nil	Nil	....	89.18
	B	2	3.86	5.18	0.04	1.51	0.05	0.04	0.38	Nil	Nil	....	88.94
	C	3	3.92	4.83	Nil	1.56	0.16	Nil	0.08	Nil	0.76	0.48	88.11
	D	3	3.78	5.08	0.14	1.86	0.02	0.01	0.12	Nil	Nil	....	89.21
	E	2	3.53	5.70	Nil	3.07	0.05	Nil	0.22	Nil	Nil	....	87.43
No. VIII	nominal	..	1.5	0.75	2.25	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (94)
	A	3	1.56	0.46	1.50	1.67	0.02	0.01	0.03	Nil	Nil	....	94.75
	B	2	1.90	0.85	2.22	1.70	0.05	0.03	0.10	Nil	Nil	....	93.15
	C	3	1.63	1.43	1.84	1.58	0.10	0.01	Nil	Nil	Nil	Nil	93.41
	D	3	1.85	0.95	2.38	1.63	0.06	0.03	0.05	Nil	Nil	....	93.05
	E	2	0.45	2.06	0.90	3.52	0.08	0.01	0.07	Nil	Nil	....	92.91
No. IX	nominal	..	4	1.5	4	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (89)
	A	3	4.12	2.30	4.31	1.19	0.63	0.01	0.28	Nil	Nil	....	87.16
	B	2	3.86	1.64	3.78	1.15	0.04	0.04	0.23	Nil	Nil	....	89.26
	C	3	4.07	1.46	3.68	1.74	0.03	0.01	Nil	Nil	Nil	Nil	89.01
	D	3	4.15	1.55	3.83	1.68	0.06	0.02	0.12	Nil	Nil	....	88.59
	E	2	3.28	3.58	1.06	4.97	0.08	0.01	0.18	Nil	Nil	....	86.84
No. X	nominal	..	....	2	5	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (91)
	A	3	0.44	2.06	4.39	1.05	0.73	0.09	0.09	Nil	Nil	....	91.15
	B	2	0.20	2.30	4.54	1.00	0.05	0.04	0.27	Nil	Nil	....	91.60
	C	3	0.52	1.93	4.61	1.47	0.04	0.01	0.08	Nil	Nil	Nil	91.34
	D	3	0.32	2.03	4.89	1.63	0.07	0.04	0.13	Nil	Nil	....	90.89
	E	2	0.76	1.78	4.29	1.88	0.06	trace	0.24	Nil	Nil	....	90.99
No. XI	nominal	..	2	8	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (88)
	A	3	2.00	7.48	0.67	0.99	0.70	0.02	0.10	Nil	Nil	....	88.04
	B	2	0.33	7.95	Nil	1.40	0.04	0.03	0.51	Nil	Nil	....	89.74
	C	3	2.09	7.65	Nil	0.90	0.03	0.03	0.06	Nil	0.16	Nil	89.08
	D	3	2.07	7.30	0.21	1.92	0.02	0.04	0.08	Nil	Nil	....	88.36
	E	2	1.46	6.86	0.37	2.91	0.04	0.01	0.36	Nil	Nil	....	87.99
No. XII	nominal	..	8	1	....	1.5 to 2	0.05[a]	0.05[a]	....	....	....	....	remainder (89)
	A	3	7.62	0.72	0.10	1.74	0.01	0.02	0.04	Nil	Nil	....	89.75
	B	2	7.86	1.20	0.04	1.60	0.02	0.18	0.14	Nil	Nil	....	88.96
	C	3	7.90	1.17	Nil	1.00	0.02	0.03	0.07	Nil	0.40	Nil	89.41
	D	3	7.55	1.48	Nil	1.97	0.01	0.03	0.09	Nil	Nil	....	88.87
	E	2	6.83	3.08	0.03	2.57	0.05	0.01	0.12	Nil	Nil	....	87.31

[a] Maximum.

high quality of work done by the cooperating laboratories. The results of these analyses for the aluminum-base alloys are shown in Table II and corresponding information for the zinc-base alloys will appear in next year's report.

Density, Metallographic and X-ray Studies:

In addition to the chemical analyses and the physical tests which included tensile strength, elongation, Rockwell hardness ("E" scale), and impact determinations, certain other studies were made by outstanding authorities for the sub-committee.

TABLE III.—RESULTS OF DENSITY DETERMINATIONS[a] BY THE U. S. BUREAU OF STANDARDS ON SPECIMENS OF ALUMINUM-BASE ALLOY DIE-CASTINGS.[b]

Alloy	Density at 25° C., g. per cu. cm.									
	Alloy from Producer A		Alloy from Producer B		Alloy from Producer C		Alloy from Producer D		Alloy from Producer E	
	Round Specimen	Flat Specimen	Round Specimen	Flat Specimen	Round Specimen	Flat Specimen	Round Specimen	Flat Specimen	Round Specimen	Flat Specimen
No. I	2.666 2.666	2.708 2.711	2.619	2.711	2.518	2.662	2.709	2.775	2.648	2.654 .....
No. II	2.708	2.800	2.755	2.723	2.726	2.798	2.879 2.880	2.876 2.878	2.775	2.780 .....
No. III	2.865	2.924	2.846	2.922	2.875	2.867	2.949	2.956	2.873 2.874	2.894 2.895
No. IV	2.627	2.677	2.575	2.633	2.585	2.587	2.669	2.685	2.700	2.713
No. V	2.581	2.662	2.561	2.559	2.547	2.573	2.624	2.607	2.583	2.668
No. VI	2.633	2.672	2.593	2.685	2.606	2.601	2.705	2.729	2.668	2.708
No. VII	2.671	2.711	2.639	2.712	2.648	2.699	2.736	2.768	2.679	2.685
No. VIII	2.649 2.650	2.768 2.769	2.611	2.671	2.399 2.400	2.648	2.701	2.756	2.609	2.669 .....
No. IX	2.717	2.814	2.696	2.772	2.692	2.731	2.776	2.766	2.721	2.580
No. X	2.614	2.729	2.606	2.700	2.669	2.687	2.754	2.777	2.678	2.671
No. XI	2.523 2.524	2.679 2.679	2.616	2.649	2.628	2.600	2.660	2.708	2.610	2.610 .....
No. XII	2.741	2.797	2.748	2.781	2.696	2.715	2.819	2.834	2.728	2.699

[a] The values in this table are believed to be correct to within ±0.002.

[b] The specimens were selected at random from lots submitted by the various producers. These identical specimens were radiographed by Mr. Ancel St. John for the sub-committee, see p. 229.

Density determinations of all the alloys from the various manufacturers were made with a high degree of precision by the U. S. Bureau of Standards. These results are shown in Table III.

Metallographic studies of the aluminum-base alloys have been made by Messrs. E. H. Dix, Jr., and J. F. Keller of the Research Bureau of the Aluminum Co. of America. They have contributed a detailed discussion in Appendix III together with low and high-power photomicrographs.

Mr. Dix has called special attention to the extremely fine detail observed in these cast structures obtained by rapid cooling encountered in the die-casting operation.

X-ray examinations calculated to reveal internal flaws in the die castings were made by Mr. Ancel St. John. The great value of this type of examination of die-cast parts in detecting the quantity and distribution of blowholes and permitting modifications in die construction to improve the soundness of die-cast parts, is discussed in detail in Appendix IV.

Statistical Analyses of Data:

Die-cast parts are economical only where identical units are produced in large quantities. It was felt at the outset of the investigation that dependable conclusions regarding the relative merits of various alloys and allowable limits could only be drawn after testing a large number of specimens. As has been previously stated, the cooperating producers prepared upwards of 80,000 die-cast specimens and distributed them to the cooperating laboratories for testing. About a third of these specimens have been tested to date and the detailed laboratory records furnished to the sub-committee. Each laboratory is testing five specimens of each alloy and each shape from each producer, and consequently all of the test information can be considered to be divisible into basic units of five observations. Appendix I contains a brief discussion of the method of statistical analysis,

TABLE IV.—TYPICAL PHYSICAL DATA SUMMARY OF TESTS ON ALUMINUM-BASE ALLOY DIE-CAST SPECIMENS FROM PRODUCER A MADE BY METALLURGICAL AND TESTING DIVISION, U. S. NAVY YARD, WASHINGTON, D. C.

Alloy	Average Tensile Strength, lb. per sq. in.		Average Deviation of Individual Tensile Strengths, per cent		Minimum Tensile Strength, lb. per sq. in.		Average Elongation in 2 in., per cent		Average Rockwell Hardness, "E" Scale (Red Figures) on Flat Specimens		Average Impact, Charpy, ft-lb.	Tensile Fractures		
	Flat	Round	Flat	Round	Flat	Round	Flat	Round	Gate End	Vent		Sound Metal	Blow-holes	Through Fillets
No. I	19 014	27 920	12.9	2.4	15 050	27 050	1.7	5.2	51.7	49.2	5.2	11	1	2
No. II	32 030	34 210	6.3	2.5	29 600	33 350	2.9	2.9	75.9	74.3	2.9	10	0	1
No. III	34 950	37 350	4.5	5.1	31 000	32 950	1.2	1.3	91.7	87.6	1.6	7	3	1
No. IV	28 690	29 000	3.0	1.5	26 750	28 400	3.8	3.9	60.6	59.6	4.5	10	0	0
No. V	33 228	32 960	6.7	4.7	29 800	29 400	1.2	1.2	85.8	85.3	1.4	8	2	2
No. VI	26 280	28 430	3.7	0.9	24 350	28 050	2.5	3.0	64.6	62.3	3.2	9	1	0
No. VII	29 620	33 830	3.9	3.4	27 250	32 450	2.5	2.8	76.2	72.2	2.6	7	3	0
No. VIII	28 120	29 850	4.3	2.3	25 100	28 250	5.0	6.0	63.5	63.2	4.1	8	2	0
No. IX	28 410	32 600	2.5	2.6	26 850	30 500	0.90	1.0	89.3	86.5	1.3	7	3	1
No. X	29 090	31 040	2.3	2.6	28 100	29 350	2.0	2.4	74.1	73.2	2.7	8	2	0
No. XI	30 010	34 010	7.2	3.2	26 100	31 850	1.8	2.7	78.6	75.7	2.6	6	4	0
No. XII	30 560	32 660	2.8	2.8	28 800	31 350	1.9	2.6	77.5	73.4	2.9	9	1	1

developed to a considerable extent by Mr. W. A. Shewhart of the Bell Telephone Laboratories, which is being applied to the study of the accumulated test data.

Test Data Summaries:

Test results of each specimen were first recorded on the test record form shown with the test procedure in the 1928 Report.[1] These data were then summarized, each summary representing one laboratory's tests on one producer's specimens. These test summaries include average results from a single laboratory on tests of five round and five flat specimens of each alloy from a single producer. In addition to the average results of determinations of tensile strength, elongation, Rockwell hardness and Charpy impact, the minimum tensile strengths and individual percentage deviations were recorded as well as observations on the tensile fractures in respect to sound metal, fillets and blowholes. The completeness of the test data now in the committee's hands may be realized when one considers that summaries have been prepared of the eight cooperating laboratories' results on tests of more than 20,000 aluminum-base alloy die-cast specimens from the five producers. Typical test data summaries for an aluminum-base and a zinc-base alloy are shown in Tables IV and V, respectively.

TABLE V.—TYPICAL PHYSICAL DATA SUMMARY OF TESTS ON ZINC-BASE ALLOY DIE-CASTING SPECIMENS FROM PRODUCER B MADE BY THE MATERIEL DIVISION, WRIGHT FIELD, DAYTON, OHIO.

Alloy	Average Tensile Strength, lb. per sq. in.		Average Deviation of Individual Tensile Strengths, per cent		Minimum Tensile Strength, lb. per sq. in.		Average Elongation in 2 in., per cent		Average Rockwell Hardness, "E" Scale (Red Figures) on Flat Specimens, Gate End	Average Impact, Charpy, ft-lb.	Tensile Fractures
	Flat	Round	Flat	Round	Flat	Round	Flat	Round			
No. XIII....	27 860	28 000	3.43	8.94	26 520	22 980	0.5	0.6	85.9	0.9	2 in blowholes
No. XIV....	41 940	44 640	2.95	2.67	38 850	41 650	0.8	2.0	97.5	3.2	1 in blowholes
No. XV.....	47 380	49 530	5.87	5.52	43 270	45 830	1.2	1.4	97.4	3.3	All good breaks
No. XVI....	49 380	48 590	5.05	3.71	46 870	46 130	1.0	1.9	99.2	4.9	All good breaks
No. XVII...	34 690	39 310	7.89	2.77	28 520	38 200	0.5	0.5	97.4	1.5	1 in blowholes
No. XVIII..	24 090	28 570	3.28	4.51	22 420	26 700	0.9	1.0	72.3	1.7	All good breaks
No. XIX....	43 960	48 150	3.73	5.50	40 550	45 030	1.7	2.1	95.5	6.1	All good breaks
No. XX.....	36 800	40 960	6.01	0.96	31 800	40 500	0.5	1.0	96.0	2.3	3 in blowholes
No. XXI....	48 530	47 820	1.45	0.78	47 600	47 000	2.0	1.9	97.3	8.2	All good breaks

Over 40 of these test data summaries have been circulated within the sub-committee as the work on the aluminum-base alloy specimens progressed and about 20 similar summaries have been circulated on the zinc-base tests. Obviously, it is impracticable to attempt to publish all of these tests *in extenso*. It is equally obvious that this information can be more readily interpreted if presented in the form of summaries and graphical charts. Certain representative charts are presented in Appendix I which are designed to present the results of the sub-committee's work, giving due weight to the numerous variables involved.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 202 (1928).

It is considered essential to repeat the caution which was given in last year's report to the effect that these test data were obtained on specimens cast mainly from virgin metals in dies of relatively simple design and under carefully controlled conditions. Consequently the data serve as a qualitative basis for evaluating and comparing alloys rather than as a quantitative basis for predicting the physical properties obtainable in die-cast parts of diverse sizes and shapes which frequently contain inserts.

The relation of the sub-committee's work to the probable characteristics of die-cast parts is discussed in some detail by Mr. Sam Tour in a technical paper prepared by him at the request of the sub-committee entitled "Aluminum Alloys for Pressure Die-Castings" presented at this annual meeting of the Society.[1] The opinions advanced in this paper should be considered as the personal views of one member of the sub-committee and not as necessarily representing the viewpoint of the sub-committee as a whole.

Atmospheric Exposure Tests:

The financing of and arranging for the atmospheric exposure tests have been carried out by a section under the chairmanship of Mr. W. M. Peirce of the New Jersey Zinc Co., Palmerton, Pa. This phase of the sub-committee's activities involved the assembly at the U. S. Bureau of Standards of about 35,000 test specimens of the 21 alloys from eight producers. These specimens have been prepared (by removing the fins, measuring for size, marking for elongation measurements, and mounting in racks) through the cooperation of the Bureau of Standards and various other sub-committee members. Racks containing all of the aluminum-base and zinc-base alloys from the various producers have been shipped to the following locations:

Outdoor Exposure....................	State College, Pa. Key West, Fla. Sandy Hook, N. J. Rochester, N. Y. Altoona, Pa. New York City.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. 487 (1929).

"Indoor" (Sheltered) Exposure........	Coco Solo, Panama Canal Zone.
	Hanover, N. Mex.
	New Kensington, Pa.
	Cambridge, Mass.

One-third of the racks will be returned to the cooperating laboratories at the end of one, three, and five-year periods, respectively. Studies will be made for measurement of changes in strength, hardness, ductility and dimensions.

Certain additional corrosion studies are being made on the zinc-base alloys. It has been reported that the stability of the zinc alloys is very largely affected by extremely small percentages of certain impurities. The atmospheric stability has been found to be determinable in relatively short time tests, by noting the loss of strength and ductility of specimens immersed in a steam bath. Accordingly, several of the cooperating laboratories are carrying out tests of the zinc-base alloys after exposures of 10 and 20 days in steam at 95° C., and of 30, 60, and 90 days in steam at 70° C. It is felt that these tests when compared with the atmospheric exposure tests will serve to correlate the two types of tests more closely than has heretofore been possible.

Future Work:

It is planned to publish the summarized results of the sub-committee's findings in the form of further statistical studies made by the Shewhart methods described in Appendix I. The future work of the sub-committee will also complete the initial physical tests and chemical analyses of the zinc-base alloys; complete the steam tests and the indoor (sheltered) and outdoor atmospheric exposure tests; evaluate the effects of the variables on the properties of specimens; correlate the properties of test specimens and die-castings; and formulate standards and indices of quality, including specifications.

Respectfully submitted on behalf of the sub-committee,

H. A. Anderson,
Chairman.

P. V. Faragher,
Secretary.

APPENDIX I

BASIS FOR ANALYSIS OF TEST RESULTS OF DIE-CASTING ALLOY INVESTIGATION

By W. A. Shewhart[1]

Introduction

A thorough discussion of all phases of the subject of the application of modern statistical theory in the analysis of test data in sufficient detail to be of value to the novice in the field of applied statistics would result in a paper of far too great length for presentation. On the other hand, if this material were condensed so as to be presentable in a single paper, such a paper would appear too abstract to be of very great use to the comparatively large number of engineers interested in possible applications of modern statistical methods in the analysis of their data. For this reason it appeared to be better to consider only a small part of the general subject and to present this in connection with actual problems confronting one of the Society's committees. Accordingly, in this paper a practical illustration is given involving the interpretation of a number of sets of data; it is shown how these data may be reduced to a few simple functions containing the essential information, and how these simple functions may be used and interpreted. More specifically, it is shown how to use three functions (1) to determine whether or not observed variations between the sets of data should be left to chance, (2) to establish standards for physical properties of raw material and (3) to establish a basis for control of product. No attempt will be made to present the detailed theory underlying the applications and no pretension is made to completeness in the discussion, but, on the other hand, attention is focussed on the presentation of definite results already found to be of interest to members of Sub-Committee XV of Committee B-2 and of general interest to all members of the Society in so far as they illustrate the application of the methods of analysis.

Statement of a Specific Problem

Briefly the initial program for Sub-Committee XV called for the preparation and testing of samples of twelve different aluminum die-casting alloys by each of five different companies. The series of tests of the physical properties of these alloys involved the taking of approximately 80,000 measurements in groups of five, that is to say, the program called for five tests on a physical property under any given condition. Any sub-group of measurements taken under essentially the same conditions, such as the preceding group of five, will be referred to as a *rational sub-group*.

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Space limitations do not permit the publication of all of these measurements. Furthermore, it would be very difficult for an engineer to grasp the significance of such a large mass of data even if they were presented. Specifically, then, the committee is faced with the problem of finding some method of recording the *essential information* contained in the original 80,000 measurements in terms of the smallest number of simple functions.[1]

Let us consider a specific illustration consisting of fifty of the 80,000 measurements. These data on tensile strength and hardness of specimens from each of five different producers are presented in Table I. All of the data in this table were taken in the same laboratory. In the sense already defined the tensile strength determinations on five specimens of producer A constitute a rational sub-group which may or may not have been made under conditions essentially the same as those of the other groups of five observations of tensile strength presented in this table. In a similar way, the five *pairs* of values of tensile strength and Rockwell hardness for the same five specimens constitute a rational sub-group.

TABLE I.—DATA FOR ALLOY NO. IV TESTED BY LABORATORY B.

Test	Producer A		Producer B		Producer C		Producer E		Producer D	
	Tensile Strength, lb. per sq. in.	Rockwell Hardness, "E" Scale	Tensile Strength, lb. per sq. in.	Rockwell Hardness, "E" Scale	Tensile Strength, lb. per sq. in.	Rockwell Hardness, "E" Scale	Tensile Strength, lb. per sq. in.	Rockwell Hardness, "E" Scale	Tensile Strength, lb. per sq. in.	Rockwell Hardness, "E" Scale
No. 1...	29 320	55.0	26 500	51.0	30 420	47.5	30 710	67.5	29 870	50.0
No. 2...	31 340	57.0	27 000	52.5	26 060	51.0	28 420	70.5	30 580	53.5
No. 3...	30 060	55.5	24 000	47.0	30 870	53.0	31 280	64.5	28 700	47.0
No. 4...	30 290	54.0	23 800	53.5	29 270	49.5	31 790	75.5	26 890	47.5
No. 5...	29 590	55.0	27 100	51.5	29 620	52.5	30 280	73.0	28 460	49.0

Three functions are introduced for representing the essential information contained in such a table of data. These functions are the average, root mean square or standard deviation, and correlation coefficient, calculated as indicated below.

Three Simple Functions

The three functions may reasonably be assumed to contain the essential information, provided the sample size is small. If the sample sizes were larger, it would be feasible to introduce certain other functions but, even in that case, these three functions would form the basis of most of the analytical work. We shall later show how some of these functions may be used.

Arithmetic Mean:

Given a series of n observations, $X_1, X_2, \ldots X_n$, of some physical quantity, X, taken under essentially the same conditions and thus constituting a rational sub-group, the arithmetic mean is defined[2] as:

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[1] In general we use data to answer certain specific questions. If the original data can be reduced to simple functions such that these functions can be used in answering a given question just as well as the original data, then these functions are said to contain the essential information in respect to the particular question.

[2] In this and all other cases to follow the summation Σ is supposed to include all values of i from 1 to n.

$$\overline{X} = \frac{X_1 + X_2 + \ . \ . \ . \ X_i \ . \ . \ . + X_n}{n} = \frac{\Sigma X_i}{n} \ldots\ldots\ldots\ldots (1)$$

The calculation of arithmetic mean is illustrated below:

TEST	TENSILE STRENGTH, X, LB. PER SQ. IN.
No. 1	29 320
No. 2	31 340
No. 3	30 060
No. 4	30 290
No. 5	29 590
	150 600

$$\text{Arithmetic mean} = \overline{X} = \frac{150\ 600}{5} = 30\ 120 \text{ lb. per sq. in.}$$

Root Mean Square or Standard Deviation:

The standard deviation of the above series of observations is almost as important a function as the average and by definition is given by the following relationship:

$$\sigma = \sqrt{\frac{\Sigma(X_i - \overline{X})^2}{n}} = \sqrt{\frac{\Sigma X_i^2}{n} - \overline{X}^2} \ldots\ldots\ldots\ldots (2)$$

The method of computing the standard deviation for the above set of observed values is illustrated below:

TEST	OBSERVED TENSILE STRENGTH, X, LB. PER SQ. IN.	SQUARE OF OBSERVED TENSILE STRENGTH, X^2
No. 1	29 320	859 662 400
No. 2	31 340	982 195 600
No. 3	30 060	903 603 600
No. 4	30 290	917 484 100
No. 5	29 590	875 568 100
		4 538 513 800

$$\text{Standard Deviation} = \sigma = \sqrt{\frac{4\ 538\ 513\ 800}{5} - (30\ 120)^2} = 699 \text{ lb. per sq. in.}$$

Correlation Coefficient:

In the majority of instances, physical properties such as hardness and tensile strength are related in some way or other, although this relationship need not be, and in general is not, functional in the mathematical sense. To measure this relationship we make use of the correlation coefficient r defined as follows:

$$r = \frac{\dfrac{\Sigma XY}{n} - \overline{XY}}{\sigma_X \sigma_Y} \ldots\ldots\ldots\ldots (3)$$

where X and Y are the two physical properties to be correlated. The method of calculating this correlation coefficient, which is a pure number, is illustrated below:

TENSILE STRENGTH, X, LB. PER SQ. IN.	ROCKWELL HARDNESS, "E" SCALE, Y	TENSILE STRENGTH × HARDNESS, XY
29 320	55.0	1 612 600
31 340	57.0	1 786 380
30 060	55.5	1 668 330
30 290	54.0	1 635 660
29 590	55.0	1 627 450
$\bar{X} = 30\,120$	$\bar{Y} = 55.3$	$\Sigma XY = 8\,330\,420$
$\sigma_X = 699$	$\sigma_Y = 0.980$	

$$r = \frac{\dfrac{8\,330\,420}{5} - (30\,120)(55.3)}{(699)(0.980)} = 0.654$$

Table II presents the essential information contained in Table I in terms of the three simple functions.

TABLE II.—DATA OF TABLE I IN TERMS OF THREE SIMPLE FUNCTIONS.

	Tensile Strength, lb. per sq. in.		Rockwell Hardness, "E" Scale		Correlation Coefficient
	Average	Standard Deviation	Average	Standard Deviation	
Producer A	30 120	699	55.3	0.980	0.654
Producer B	25 680	1469	51.1	2.223	0.289
Producer C	29 248	1692	50.7	2.105	−0.020
Producer E	30 496	1157	70.2	3.894	0.026
Producer D	28 900	1268	49.4	2.311	0.815

We have no intention of considering all of the ways in which these three functions may be used in the interpretation of a series of data such as are now being accumulated by Sub-Committee XV. Instead we shall illustrate only the ways in which these simple functions may be used in detecting things which should not be left to chance, in setting standards, and in forming the basis for the control of quality of product—in this case die-castings.

WHEN SHOULD OBSERVED VARIATIONS IN THE PHYSICAL PROPERTIES OF AN ALLOY BE LEFT TO CHANCE?

Let us see how these simple functions may be used to determine whether or not the committee's instructions for casting a given alloy, in this case Alloy No. IV, really specify in the sense that they reasonably preclude the occurrence of differences in product greater than should be attributed to chance. Specifically, let us consider the data of Table I representing the test results of alloys from five different producers. It is interesting to know whether or not these five producers, all working under the same instructions, produced samples which differ from similar samples of other producers to an extent not greater than should reasonably be left to chance.

We shall assume that variations must be left to chance only when due to what we define as a constant system of chance causes among which no single cause or distinguishable group of causes appears to have a predominating effect.[1]

It may be shown that in practice there are at least four criteria which may be used for detecting when such fluctuations need not be left to chance. Here we must be content to present only one of these but this one is believed to be sufficient for most of the problems connected with the present study. It is called Modified Criterion I and its method of application can best be illustrated by outlining the detailed steps of applying it to the tensile strength data of Table I.

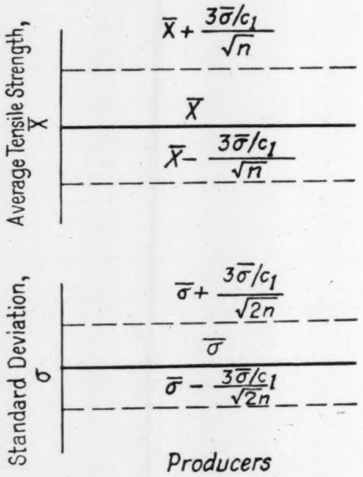
Average Tensile Strength, $\bar{X}$
$\bar{X} + \frac{3\bar{\sigma}/c_1}{\sqrt{n}}$
$\bar{X}$
$\bar{X} - \frac{3\bar{\sigma}/c_1}{\sqrt{n}}$
Standard Deviation, σ
$\bar{\sigma} + \frac{3\bar{\sigma}/c_1}{\sqrt{2n}}$
$\bar{\sigma}$
$\bar{\sigma} - \frac{3\bar{\sigma}/c_1}{\sqrt{2n}}$
Producers

FIG. 1.—Schematic Diagram of Method of Presenting Test Data.

The results of applying this criterion may be and usually are presented graphically in the form schematically illustrated in Fig. 1. The two charts shown in this figure are really control charts for averages and standard deviations and they are obtained as illustrated in the figure itself. Two symbols appear

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[1] If a variable X is not continuous but is controlled by a constant system of chance causes, finite in number, we assume that it can take on only a finite number M of different values, say

$$X_1', X_2', \ldots, X_i', \ldots, X_M'$$

with the probabilities of occurrence

$$p_1', p_2', \ldots, p_i', \ldots, p_M'.$$

Such a variable is said to be controlled by a constant system of chance causes, because the probability p_i' of obtaining a particular value X_i' is the same every time a value of X is observed.

If, however, the variable X is continuous, so that in any small interval it takes on all possible values, then in contradistinction to the case of the discrete variable, the probability dy' of obtaining a value of X between X and $X + dX$ is constant every time a value of X is observed. This probability is defined symbolically by:

$$dy' = f(X, \lambda_1, \lambda_2, \ldots, \lambda m')dX,$$

where f is the functional form defining the distribution of effects of the cause system involving m parameters.

Any set of n observed values of X, therefore, may be taken as a sample of the possible effects of such a system of causes.

If the system of causes is not constant, it is said to contain an assignable cause of variation.

If a constant system of causes contains one predominating cause or group of causes, we term this one cause or group of causes an assignable cause of variation.

which up to the present time have not been defined. The first of these is the average standard deviation $\bar{\sigma}$ and the second is the correction factor c_1 which is a function of the size of sample, n, and which may be read directly from the curve given in Fig. 2.

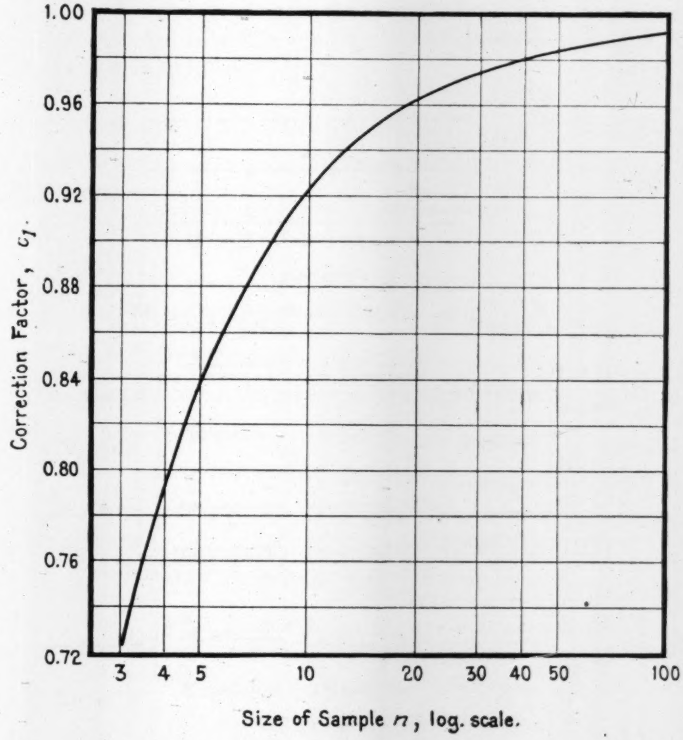

FIG. 2.—Curve for Determining Correction Factor c_1 for Obtaining Expected Standard Deviation $\bar{\sigma}$ of Sample of Size n.

Making use of the data in Table II, the method of constructing the control chart is illustrated further: Substituting the numerical values and using the value 0.84 for c_1 (as read from Fig. 2) we get the following results:

$$\bar{X} + \frac{3\frac{\bar{\sigma}}{c_1}}{\sqrt{n}} = 30{,}895 \text{ lb. per sq. in.} \qquad \bar{\sigma} + \frac{3\frac{\bar{\sigma}}{c_1}}{\sqrt{2n}} = 2675 \text{ lb. per sq. in.}$$

$$\bar{X} - \frac{3\frac{\bar{\sigma}}{c_1}}{\sqrt{n}} = 26{,}883 \text{ lb. per sq. in.} \qquad \bar{\sigma} - \frac{3\frac{\bar{\sigma}}{c_1}}{\sqrt{2n}} = -161 \text{ lb. per sq. in.}^{1}$$

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[1] This is taken to be zero because negative values of σ are not possible.

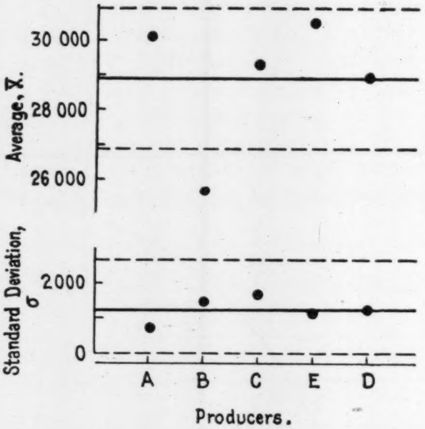


FIG. 3.—Typical Control Charts (Alloy No. IV).

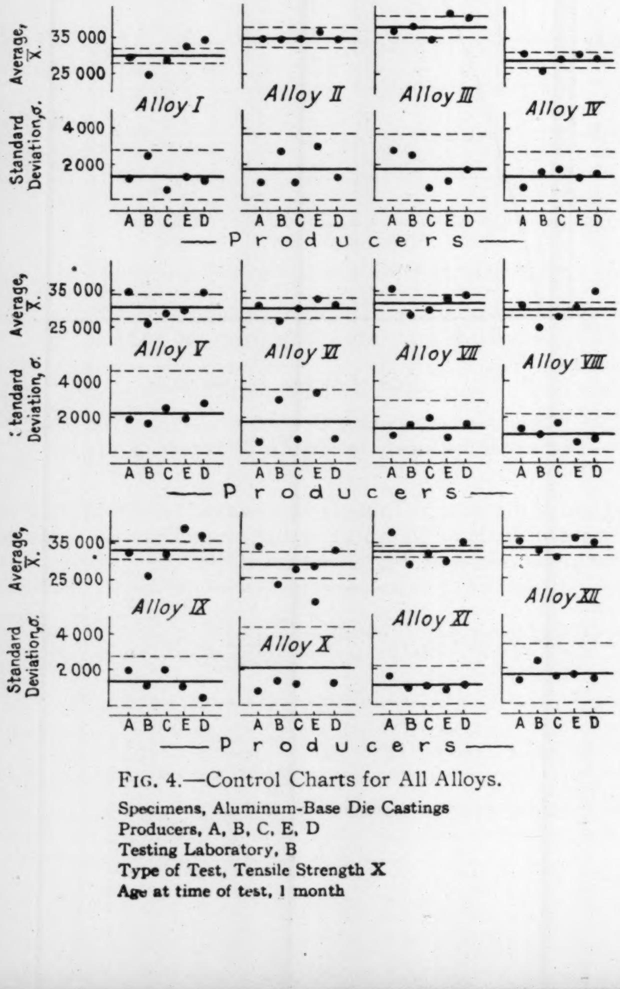
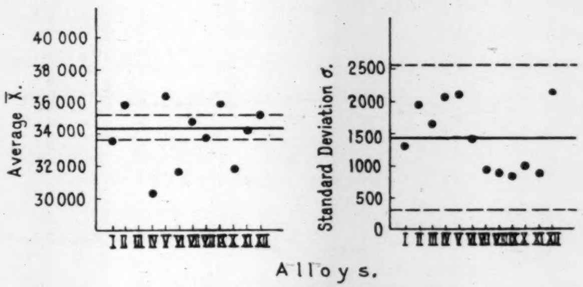


FIG. 4.—Control Charts for All Alloys.

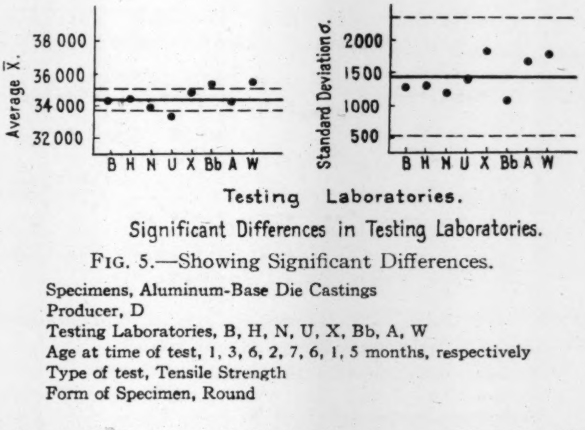
Specimens, Aluminum-Base Die Castings
Producers, A, B, C, E, D
Testing Laboratory, B
Type of Test, Tensile Strength X
Age at time of test, 1 month

These averages and limit lines together with the observed values are shown in the control charts of Fig. 3.

If the observed values of average and standard deviation fall outside the limits so established, it is taken as a positive indication of the presence of causes of variation which should not be left to chance. In the present instance we find rather definite evidence of such a cause of variation so that we conclude that further study should be made to find these causes of variation so that specifications may be so written as to eliminate deviations of this nature in future production of samples of Alloy No. IV.



Significant Differences in Alloys.



Significant Differences in Testing Laboratories.

FIG. 5.—Showing Significant Differences.

Specimens, Aluminum-Base Die Castings
Producer, D
Testing Laboratories, B, H, N, U, X, Bb, A, W
Age at time of test, 1, 3, 6, 2, 7, 6, 1, 5 months, respectively
Type of test, Tensile Strength
Form of Specimen, Round

Three other typical charts of this nature are reproduced as distributed to members of the committee. The first of these, Fig. 4, shows control charts on each of the twelve alloys of the same kind as those presented in Fig. 3 for Alloy IV. Here again we find further evidence of the fact that the specifications for the different alloys in the present form do not preclude the existence of assignable causes of variation which should not be left to chance.

Figure 5 presents similar charts indicating that the alloys themselves are significantly different one from another while Fig. 6 presents information indicating that there are significant differences between the testing laboratories which should be found and eliminated before it is possible to make complete use of the data in establishing the standards for the physical properties of the materials. Further consideration of the significance of the information presented in these different charts is reserved for treatment elsewhere in the report.

USE OF FUNCTIONS IN SETTING STANDARDS FOR PHYSICAL PROPERTIES

One of the fundamental objects of the work of a committee of the Society is to fix standards for the physical properties of materials. For example, in the case of the tensile strength of aluminum-alloy die-castings, after having taken a series of observations and having shown that these give no indication of the presence of causes of variation which should not be left to chance, it is necessary that we give some figures which will indicate the value of tensile strength to be expected for such an alloy and some measure of the dispersion or variation about this expected value. In other words for every alloy controlled by a constant system of chance causes, there is some expected value $\overline{X'}$ for a

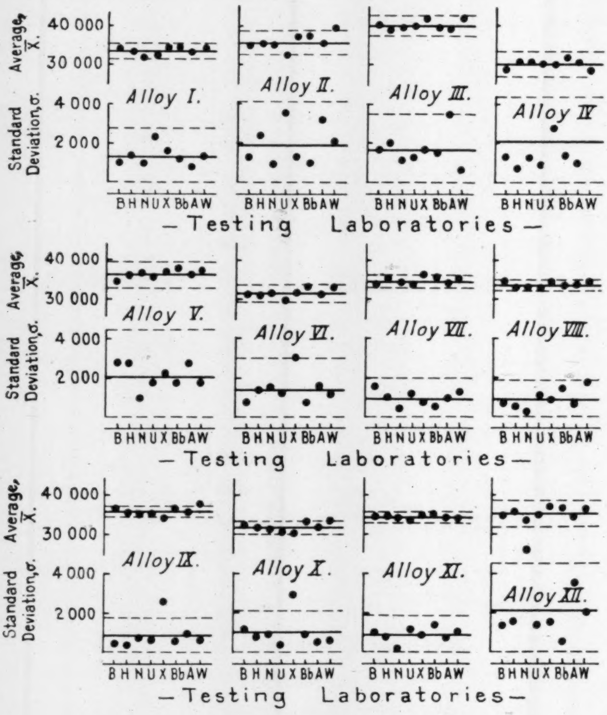


FIG. 6.—Control Charts Indicating Significant Differences Between Testing Laboratories.

Specimens, Aluminum-Base Die Castings
Producer, D
Testing Laboratories, B, H, N, U, X, Bb, A, W
Age at time of test, 1, 3, 6, 2, 7, 6, 1, 5 months, respectively
Type of Test, Tensile Strength
Form of specimen, Round

given quality characteristic and some true standard deviation σ' for this same quality characteristic.

Naturally, we can never be sure that we know these true values, namely, the expected value and the standard deviation in any given case. The best we can do is to make certain estimates of these. It is beyond the scope of the present paper to consider more than one method for doing this. However, this method, subject to the indicated assumptions, has proved quite satisfactory in those cases coming to our attention.

Having taken a series of observations such as that presented in Table I, having found no indication of existence of assignable causes of variation, and having no other information upon which to base a standard, the following procedure may be followed. As an estimate of the expected value $\overline{X}'$, we may take the arithmetic mean $\overline{X}$ of all of the observations on that given property.

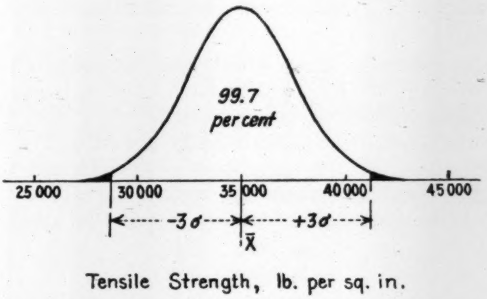


FIG. 7.—Distribution Curve.

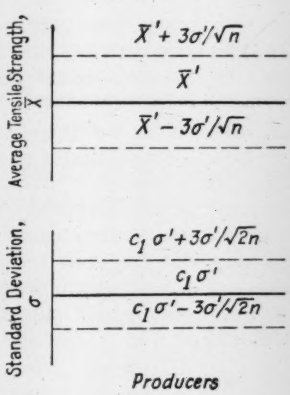

Average Tensile Strength, $\overline{X}$
$\overline{X}' + 3\sigma'/\sqrt{n}$
$\overline{X}'$
$\overline{X}' - 3\sigma'/\sqrt{n}$
Standard Deviation, σ
$c_1\sigma' + 3\sigma'/\sqrt{2n}$
$c_1\sigma'$
$c_1\sigma' - 3\sigma'/\sqrt{2n}$
Producers

FIG. 8.—Schematic Diagram of Control Chart.

As an estimate of the true standard deviation σ' we may take $\frac{\overline{\sigma}}{c_1}$ where $\overline{\sigma}$ is the mean standard deviation of the rational sub-groups calculated in the way indicated in the previous section and c_1 is the correction factor given in Fig. 2. This method is perhaps quite satisfactory provided the total number of observations is not less than 25. In this case we may also take the observed correlation coefficient as a tentative standard for the correlation coefficient r_{ij} between any two quality characteristics X_i and X_j.

Since the information presented in Table I, when tested by means of Modified Criterion I gives indication of the presence of assignable causes, we are not justified in the light of what has just been said in using these data for the setting of standards. Figure 4 shows, however, that in the case of Alloy No. II there is no evidence of the presence of assignable causes, and hence, we may use these data to illustrate the method of setting standards for the expected value and standard deviation for the two properties, tensile strength and hardness. The estimates of tentative standards for Alloy No. II are presented below:

	ESTIMATE $\bar{X}$ OF EXPECTED VALUE $\bar{X}'$	ESTIMATE $\bar{\sigma}/c_1$ OF TRUE STANDARD DEVIATION σ'
Tensile Strength, lb. per sq. in.	35 002	2069
Rockwell Hardness, "E" Scale	76.7	4.0

Now we may go one step further and see how these estimates of average and standard deviation may be interpreted. This may best be illustrated by means of Fig. 7 drawn for the case of tensile strength of Alloy No. II. This merely indicates that, based upon the assumption that the accepted average and standard deviation are the values given above, the expected distribution will not differ much from that illustrated schematically in this figure where approximately 99.7 per cent of the area under the curve lies within the limits therein indicated.

USE OF SIMPLE FUNCTIONS FOR CONTROL PURPOSES

One of the three previously mentioned purposes of using observed data of the type under discussion is to establish a basis for control of future product of this kind. For example, suppose that certain standards for average and standard deviation have been accepted for a given kind of alloy and let us call these standard values $\bar{X}'$ and σ' respectively.

Suppose now that a producer wishes to know whether or not his product differs from standard product by more than should be attributed to chance. He may use the accepted standards for the physical properties as a basis for establishing a control chart similar to the one schematically shown in Fig. 8. He may also establish a control chart for the correlation coefficient but the details of doing this will not be gone into here because the work of the committee has not proceeded far enough to make available illustrative material for making such a chart.

APPENDIX II

DIE-CASTING PROGRESS IN EUROPE

By E. V. Pannell[1]

Great Britain

According to a British authority, die casting has not made the commercial progress which was expected, and permanent mold castings which have trebled their production during the past year have temporarily limited the sales of die castings. American machines of the automatic type are now being adopted in England, however, and the industry is expected to develop more rapidly. A die-casting committee is attached to the British Non-Ferrous Research Association and has recently undertaken an interesting program for the study of the permanence of zinc-base alloys. This work was briefly reported by T. F. Russell and his colleagues at a meeting of the British Institute of Metals in October, 1928. A summary of the work so far reported is as follows:

Alloys Tested:

In the following list of zinc-base alloys it is interesting to note the high percentages of tin used. It is further of note that no special emphasis is placed on the use of high-grade or electrolytic zinc:

Alloy	Zinc, per cent	Copper, per cent	Tin, per cent	Aluminum, per cent	Other Elements, per cent
No. 1	90.75	3.17	5.67	0.41	....
No. 2	89.08	3.16	7.40	0.36	....
No. 3	85.57	3.72	9.73	0.98	....
No. 4	82.66	3.07	13.83	0.44	....
No. 5	74.29	3.11	22.31	0.29	....
No. 6	88.22	1.20	9.70	0.98	....
No. 7	89.13	1.06	8.35	0.37	Ni, 1.09
No. 8	84.86	3.66	9.65	0.86	Cd, 0.97
No. 9	93.33	2.72	....	3.95	....
No. 10	92.01	3.07	0.28	9.64	....
No. 11	90.70	5.14	....	4.16	....
No. 12	88.96	7.02	....	4.02	....
No. 13	92.30	3.03	....	3.87	Pb, 0.80
No. 14	92.76	3.04	....	3.44	Pb, 0.75
No. 15	92.81	3.02	....	4.07	Mg, 0.095
No. 16	92.90(HH)	7.94	....	4.02	Mg, 0.107

Testing Bar Casting:

A manual plunger machine was used for casting the specimens and the latter were of the form shown in the accompanying Fig. 1. Effects of temperature of metal pot and dies including ice cooling of the latter were studied in addition to various sizes of gate. The factor having the greatest influence was the speed of pouring as affected by operation of the lever.

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[1] **Technical Adviser, The British Aluminium Co., Ltd., New York City.**

Physical Tests:

In a grouped form the average tensile strengths were reported as follows:

	QUICK PULL TESTS		SLOW PULL TESTS	
ALLOYS	TENSILE STRENGTH, LB. PER SQ. IN.	POROSITY, PER CENT	TENSILE STRENGTH, LB. PER SQ. IN.	POROSITY, PER CENT
Zn-Sn Group...........	21 000	6.91	21 300	3.30
Zn-Al Group...........	42 200	5.75	44 800	3.63

Comparative tests on the Zamac samples are not yet available. The porosity was determined by weighing the samples in comparison with a weighed gravity cast specimen of the same alloy.

Hardness and transverse bending tests were also made but were inconclusive.

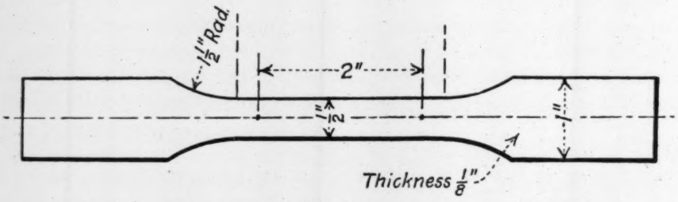

FIG. 1.—Die-Cast Test Specimen for Zinc-Base Alloys.

It is reported that the alloys containing aluminum in too high a percentage give trouble due to the design of the machine. Nickel also is troublesome and apparently added nothing to the physical properties. Cadmium to the extent of 1 per cent facilitated casting and improved the appearance of the product.

Exposure Tests:

Swelling or distortion has been associated with the alloys containing aluminum rather than with those containing tin. Tests show there is little actual difference. Permanence was tested under air and steam conditions. With air exposure tensile strength showed no apparent change after six months. Dimensions of the tin group alloys showed little or no change after the first few days. Those of the aluminum group contract in size, especially in the first month after casting. Steam tests were made in a closed tank with vapor at 158° F. The resulting change in length was measured by a dilatometer and amounted to from 0.15 to 0.42 per cent after 200 hours' exposure. All castings appear to grow at the same rate after the initial period of contraction is over. The exposure tests were not carried to the final disintegration of the sample. Growth or swelling is found to be virtually independent of composition but is affected by the shape of casting and porosity.

Action of Zinc-Base Alloys on Iron and Steel:

Further experiments were made to determine the solvent action of zinc on steel and iron as used for dies, plungers, and metal pots. The only material to resist attack was mild steel with a calorized surface. All other ferrous metals were dissolved. These tests were made with pure zinc which is believed to act more rapidly than the alloys, particularly those containing aluminum.

Respecting the presence of lead in zinc-base alloys, Russell reports the composition of "Tenax" die-casting alloy as follows:

Zinc, per cent	91.4
Copper, per cent	2.8
Aluminum, per cent	4.6
Lead, per cent	1.2

The tensile strength reported is 30,000 lb. per sq. in. Another British authority, however, states that as much as 0.75 per cent of lead renders such an alloy chemically active and it will involve bubbles of hydrogen in distilled water at ordinary temperatures. One metallurgist states that swelling and growth of zinc-base castings can be prevented by the addition of nickel and chromium to the alloy and the absence of lead and cadmium. He quotes the following range of composition for British practice:

Zinc, per cent	85 to 90
Copper, per cent	3.5 to 3
Tin, per cent	10 to 5
Aluminum, per cent	1 to 0.5

Aluminum-base alloys as cast in Britain are of the B.E.S.A. standard compositions of 8 and 12 per cent of Copper, also the "Y" Alloy of 4 per cent copper, 2 per cent nickel and 1.5 per cent magnesium. Also used are the 13 per cent of silicon alloy, and one of 3.7 per cent copper and 7.5 per cent magnesium.

Other die casters favor the use of a 5 to 7-per-cent copper alloy hardened with about 0.1 per cent of manganese. Aluminum-copper-nickel alloys are also used.

Aluminum, per cent	90	94.5
Copper, per cent	8	2.5
Nickel, per cent	2	3.0

Magnesium-base alloys are being die cast in the following compositions:

				ELEKTRON
Magnesium, per cent	95.0	94.0	90	93.35
Zinc, per cent	4.5	....	..	4.30
Copper, per cent	0.5	....	..	0.75
Aluminum, per cent	...	6.0	10	1.60

Magnesium is coming into favor because it is easy to die cast, the castings are very sound and there is apparently no attack on the metal pot or the die. Brass die casting is under research and is expected to be on a commercial basis sooner or later.

GERMANY

Investigations of the causes of swelling and distortion of zinc-base alloys have been carried on by a committee of the Deutsche Gesellschaft für Metallkunde for the past four years. It was concluded that growth was prevalent with all castings but especially those of high impurity content and containing aluminum. Zinc-tin alloys are regarded as sufficiently permanent for commercial purposes if the accuracy required is not too close. Deterioration of tensile strength, however, is shown to take place. The presence of 1 per cent of lead in commercial zinc is stated to have no bad effect on the castings. Some of the troubles due to swelling have been charged to the low-grade metals used immediately after the World War, and to the use of an appreciable percentage of aluminum and tin in the same alloy.

FRANCE

The following light alloys are in use for die castings:

Aluminum, per cent	95	91	87	92
Copper, per cent	2	4	..	3
Silicon, per cent	3	5	13	3
Nickel, per cent	..	..	..	2
Tensile Strength, lb. per sq. in.	27 500	30 000	30 000	..
Elongation, per cent	3 to 6	2.5 to 4	3 to 5	..
Brinell Hardness	55 to 85	60 to 70	70 to 80	..

Reference is made to the following list of articles appearing in the technical journals:

LIST OF ARTICLES

"Alloys for Die Casting," *Machinery* (London), Vol. 31, p. 397.

T. F. Russell. "General Aspects of Die Casting," *Metal Industry* (London), Vol. 32, January 1928.

"Die Casting Machine for Trial Parts," *Machinery* (London), Vol. 32, p. 97.

"A Large Die-Casting Die," *Machinery* (London), Vol. 33, p. 122.

"Le Fonderie sous Pression de Vazeilles," *L'Usine* (Paris), No. 52, 1927.

"Alliages d'Aluminium Employes en Fonderie," *La Revue d'Aluminium*, No. 19, p. 456.

Peter, "Spritzgusstechnik," *Aluminium* (Berlin), No. 5, p. 3, 1927.

APPENDIX III

MICROSCOPIC ANALYSIS OF SPECIMENS OF DIE-CAST ALLOYS

By E. H. Dix, Jr.,[1] and J. F. Keller[2]

A series of micrographs has been prepared to show the characteristic structures of Alloys I to XII, which are typical of the alloys investigated by Sub-Committee XV. The chemical analyses of these alloys are as follows:

Alloy	Copper, per cent	Silicon, per cent	Nickel, per cent	Iron, per cent	Zinc, per cent	Manganese, per cent	Tin, per cent	Aluminum, by difference, per cent
No. I......	4.21	0.36	0.00	1.39	0.08	0.01	0.00	93.95
No. II......	7.11	0.34	0.00	1.97	0.14	0.01	0.00	90.43
No. III.....	11.99	0.47	0.00	1.90	0.18	0.01	0.00	85.45
No. IV.....	0.66	3.59	0.02	1.89	0.64	0.01	0.00	93.79
No. V......	0.60	13.17	0.11	1.65	0.52	0.26	0.00	83.69
No. VI.....	2.00	3.03	0.37	1.26	0.29	0.68	0.00	92.37
No. VII ...	3.35	5.06	0.11	1.45	0.60	0.30	0.00	89.13
No. VIII...	1.56	0.39	1.58	1.67	0.08	0.01	0.00	94.71
No. IX.....	4.05	2.21	4.22	1.18	0.43	0.70	0.00	87.21
No. X......	0.40	2.13	3.95	0.97	0.21	0.78	0.00	91.55
No. XI.....	1.83	7.71	0.31	0.92	0.20	0.77	0.00	88.25
No. XII....	7.33	0.67	0.08	1.80	0.10	0.01	0.00	90.00

The sections for microscopic examination were prepared as follows: Pieces about $\frac{3}{8}$ in. long were sawed from the center section of both the flat and round tension test specimens. These pieces were mounted in sulfur in such a way that the transverse cross-section could be prepared for examination, as outlined in the Society's Standard Methods of Metallographic Testing of Non-ferrous Metals and Alloys (E 5 - 27)[3], except that the use of the emery papers was eliminated by taking a cut on the Jung microtome.[4] The specimen was then taken directly to the wet polishing wheels. All of the specimens were etched in a mixture of 1 part HF, $1\frac{1}{2}$ parts HCl, $2\frac{1}{2}$ parts HNO_3 in 95 parts of water.[5]

Macrographs were taken at a magnification of 10 diameters, of all sections. The details of the structure were then illustrated in micrographs at a magnification of 500, and in a few cases at 1500 diameters. The macrographs at 10 diameters show the entire transverse cross-section of both flat and round tensile specimens and illustrate the amount of shrinkage porosity.

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[1] Metallurgist, Research Bureau, Aluminum Co. of America, New Kensington, Pa.

[2] Assistant Metallurgist, Research Bureau, Aluminum Co. of America, New Kensington, Pa.

[3] 1927 Book of A.S.T.M. Standards, Part I, p. 769.

[4] F. F. Lucas, "Application of Microtome Methods to the Preparation of Soft Metals for Microscopic Examination," *Proceedings*, Inst. of Metals Division, Am. Inst. Mining and Metallurgical Engrs., p. 481 (1927).

[5] Described by Dix and Keller in *Journal of Mining and Metallurgy*, July, 1928.

The micrographs at a magnification of 500 diameters show the eutectic network, but at this magnification it is almost impossible to distinguish the different constituents present. The micrographs at 1500 diameters aid in the identification of constituents, but even at this magnification it was extremely difficult to identify certain constituents. A rather incomplete scheme for the identification of constituents has been given by Dix and Keith.[1]

There are, however, a number of the complex constituents which are not included in the work referred to. These constituents all probably contain aluminum and two or more other elements. For instance, two aluminum-iron-silicon constituents have been identified. For the sake of uniformity and simplicity these are designated α (Fe-Si) and β (Fe-Si). Only one aluminum-iron-silicon constituent was known at the time the scheme for identification was prepared. There are many other such complex constituents, about which even less is known. It is, therefore, quite impossible to identify all of the constituents occurring in the network of these die-cast alloys. The very fine particle size makes the identification particularly difficult. However, it seems to be desirable to describe the structure as completely as possible. Therefore, certain constituents are mentioned in the description of the micrographs, although the exact differentiation of these constituents is not possible at the present time. The method of designating these constituents suggested by Dix and Heath[2] has been employed.

The rapid cooling these specimens had undergone in solidifying had caused a retention of an appreciable amount of the soluble constituents in solution. The network structure in all cases was extremely small and it appeared that the size of the network at 500 diameters in these alloys was approximately the size of the network seen at 100 diameters in sand-cast specimens of similar aluminum alloys.

The macrographs at 10 diameters were taken using a 75-mm. Zeiss Micro-Tessar lens. At 500 diameters a 4-mm., 0.65 N.A. apochromatic objective was used in combination with a 5X hyperplane eyepiece and at 1500 diameters a 3-mm., 1.4 N.A. apochromatic oil immersion objective was used in connection with a 5X hyperplane eyepiece. The plates used were Ortho Slow Hammer and the prints were made on Azo F3 paper.

Acknowledgment.—Acknowledgment is due to Mr. George W. Wilcox for his aid in preparing the specimens and photomicrographs.

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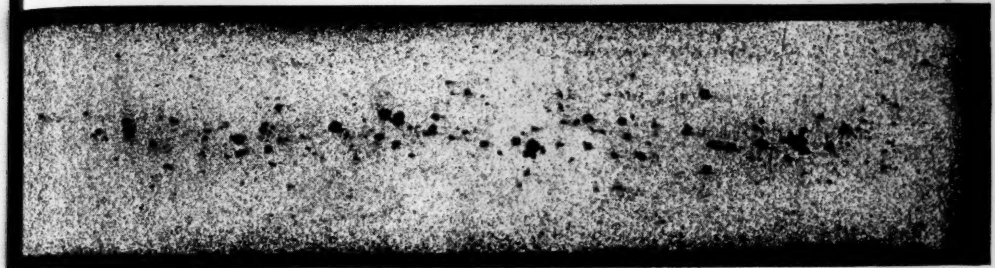
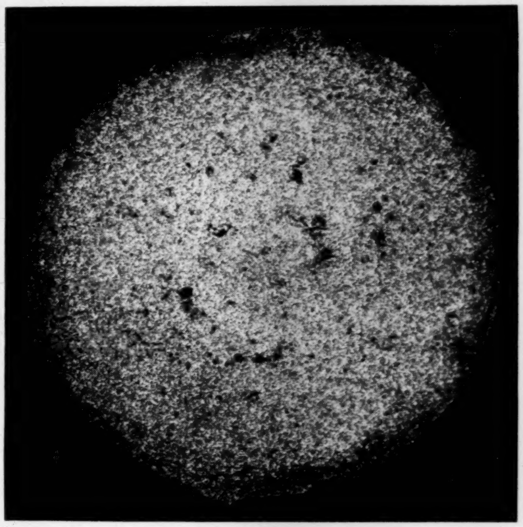
[1] E. H. Dix, Jr., and W. D. Keith, "The Etching Characteristics of Constituents in Commercial Aluminum Alloys," *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part II, p. 317 (1926).

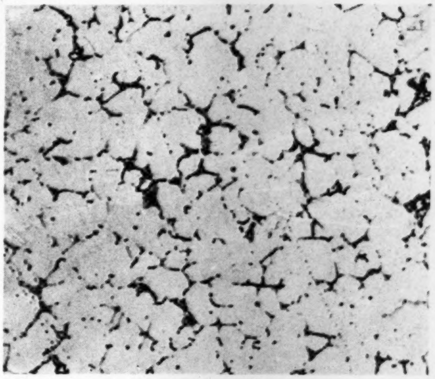
[2] E. H. Dix, Jr., and A. C. Heath, Jr., "Equilibrium Relations in Aluminum-Silicon and Aluminum-Iron-Silicon Alloys of High Purity," *Proceedings*, Inst. of Metals Division, Am. Inst. Mining and Metallurgical Engrs., p. 164 (1928).



(*a*) Cross-section through gage length of flat test specimen (× 10). Shows area of porosity in center of section.



(*b*) Cross-section through gage length of round test specimen (× 10). A few shrinkage cavities appear in the center of the specimen.

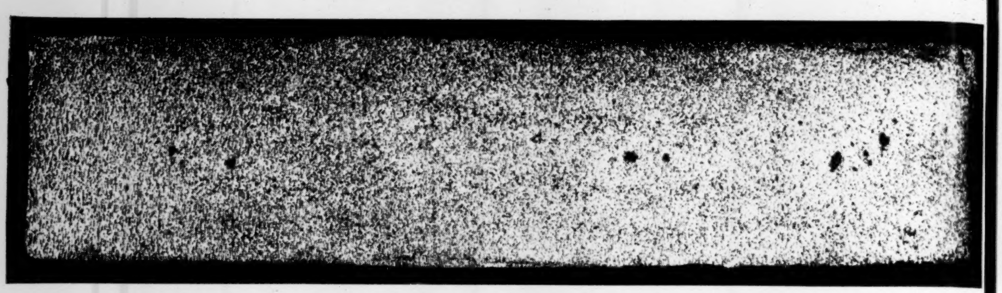


(*c*) Shows eutectic network probably composed of α (Cu-Fe), β (Cu-Fe) and α (Fe-Si) (× 500). The matrix is a solid solution of aluminum, copper and silicon.

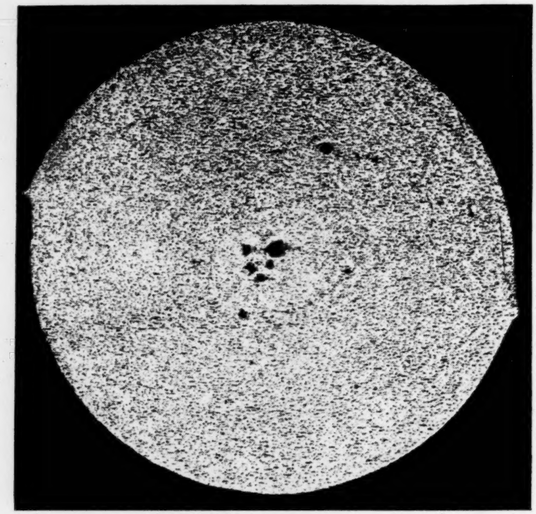
FIG. 1.—Macrographs and Micrograph of Specimens of Alloy No. I. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

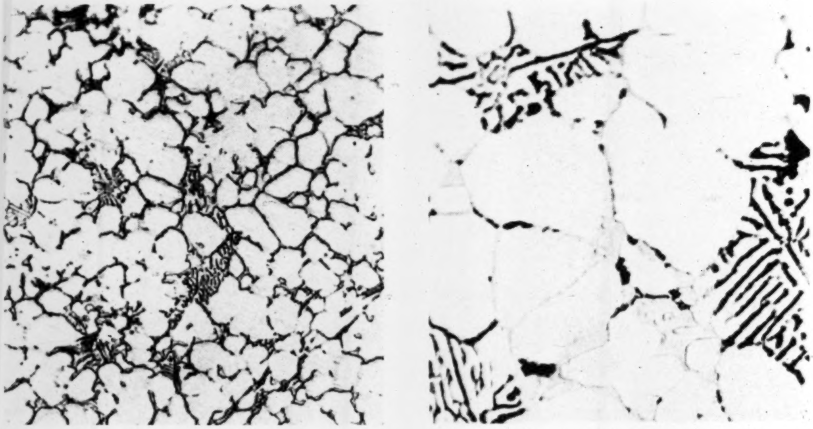
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Aluminum, by difference
4.21	0.36	0.00	1.39	0.08	0.01	93.95



(*a*) Cross-section through gage length of flat test specimen (× 10). This section exhibited only a few areas of porosity.



(*b*) Cross-section through gage length of round test specimen (× 10). A few areas of porosity are shown in the center of the section.



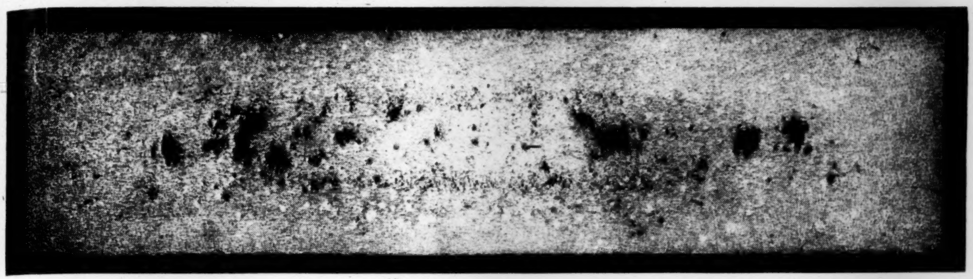
(*c*) Shows network of constituents (× 500).

(*d*) The constituents present are probably $CuAl_2$, α (Cu-Fe), α (Fe-Si) and β (Cu-Fe) (× 1500).

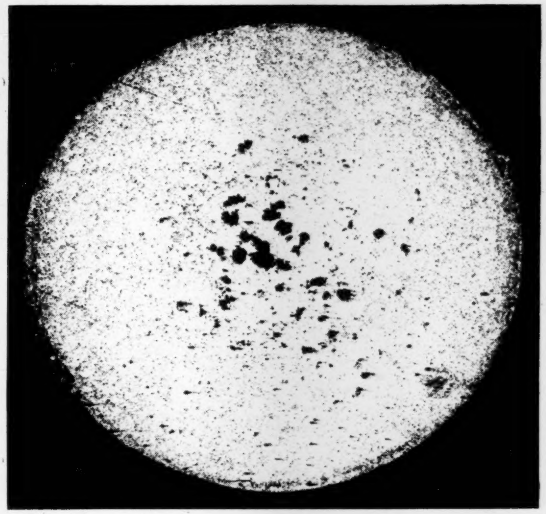
FIG. 2.—Macrographs and Micrographs of Specimens of Alloy No. II. Etching Reagent, $HF\text{-}HCl\text{-}HNO_3$.

ANALYSIS, PER CENT:

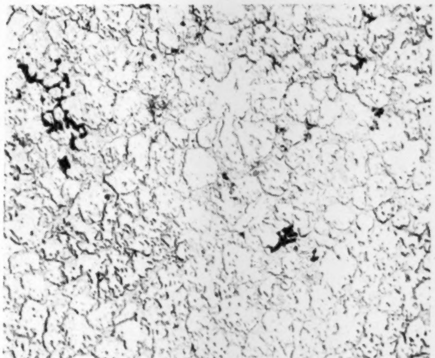
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
7.11	0.34	0.00	1.97	0.14	0.01	0.00	90.43



(*a*) Cross-section through gage length of flat test specimen (× 10). This section showed a number of areas of porosity in the central portion.



(*b*) Cross-section through gage length of round test specimen (× 10). An area of porosity occurs in the central portion of the section.

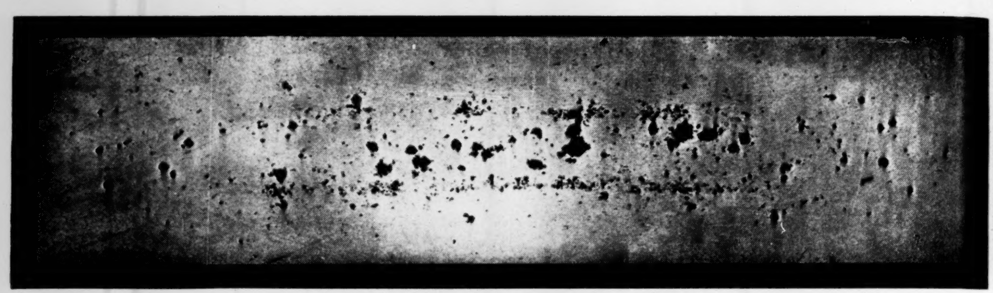


(*c*) Shows network which probably consists of α (Cu-Fe), $CuAl_2$ and β (Cu-Fe) in solid solution matrix (× 500).

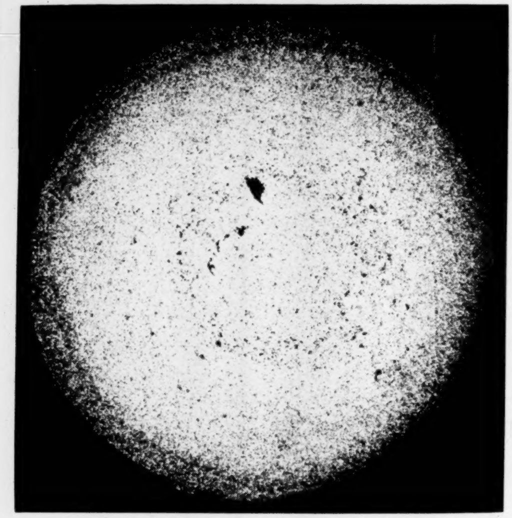
FIG. 3.—Macrographs and Micrograph of Specimens of Alloy No. III. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

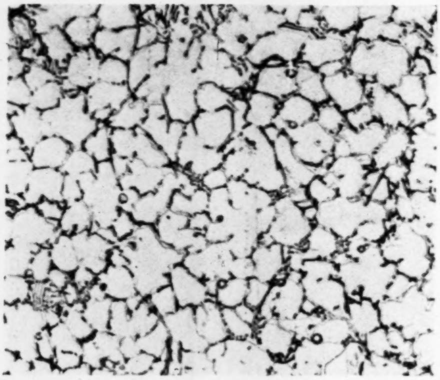
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
11.99	0.47	0.00	1.90	0.18	0.01	0.00	85.45



(*a*) Cross-section through gage length of flat test specimen (× 10). This section showed a large number of porous areas.



(*b*) Cross-section through gage length of round test specimen (× 10). The dark band around the perifery of the section indicates a very fine grain structure resulting from rapid cooling. The section shows some very fine porous areas in the central portion.

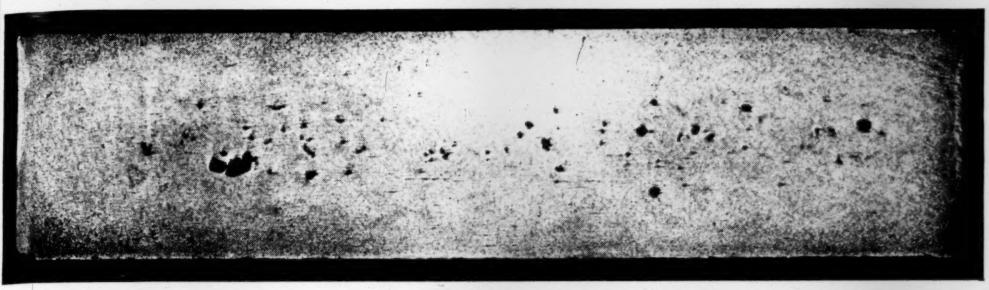


(*c*) Shows network structure probably consisting of α (Fe-Si), β (Fe-Si) and silicon in a solid solution matrix (× 500).

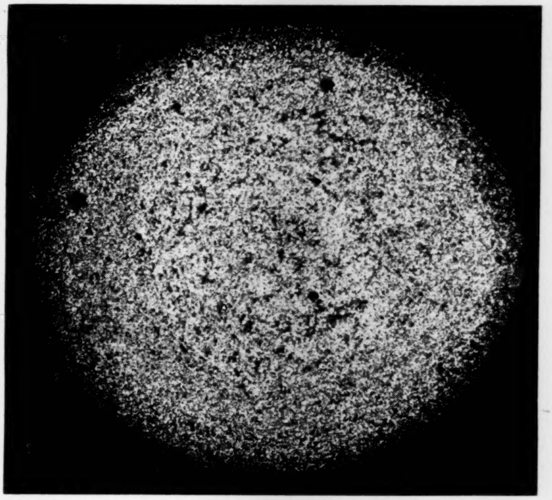
FIG. 4.—Macrographs and Micrograph of Specimens of Alloy No. IV. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

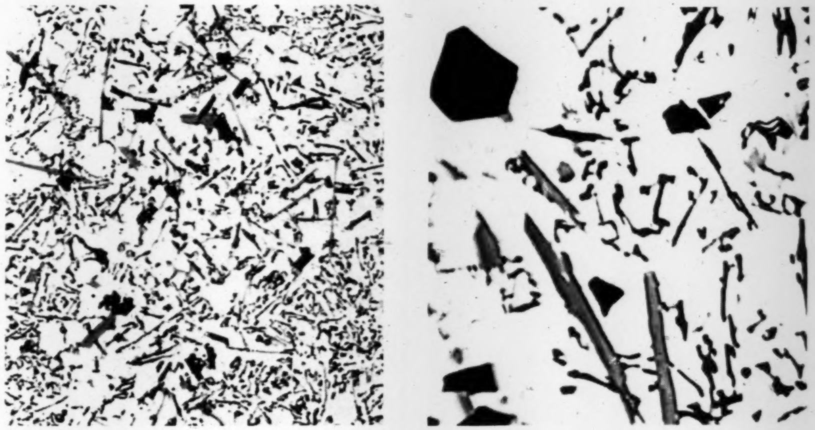
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
0.66	3.59	0.02	1.89	0.04	0.01	0.00	93.79



(a) Cross-section through gage length of flat test specimen (× 10). Shows some areas of porosity in the central portion of the specimen.



(b) Cross-section through gage length of round test specimens (× 10). A few areas of porosity are distributed throughout the section.



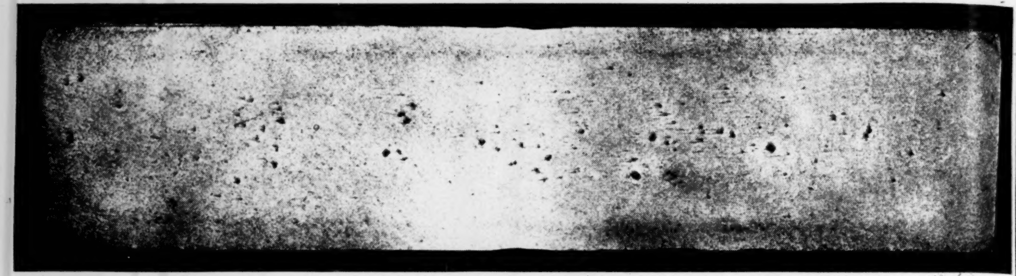
(c) Shows network of constituents in solid solution matrix (× 500).

(d) Shows constituents consisting of silicon (dark) and β (Fe-Si) (light needles) (× 1500).

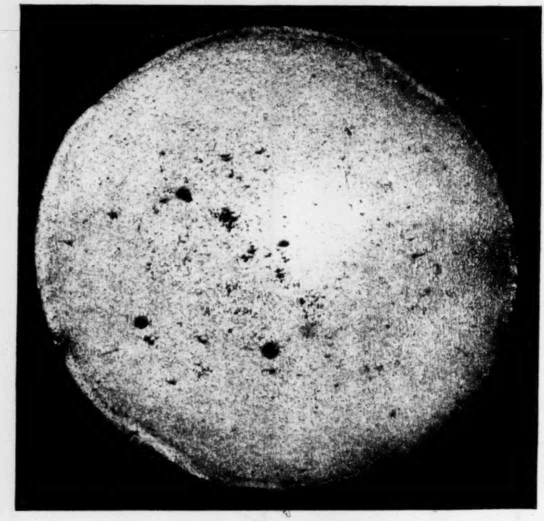
FIG. 5.—Macrographs and Micrographs of Specimens of Alloy No. V. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

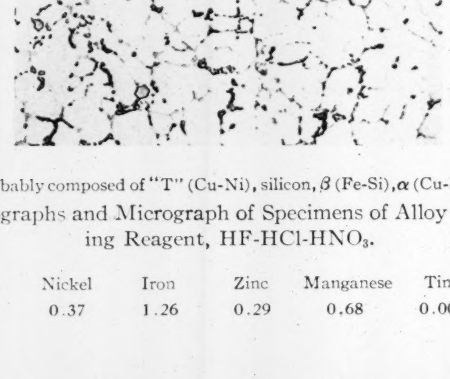
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
0.60	13.17	0.11	1.65	0.52	0.26	0.00	83.69



(a) Cross-section through gage length of flat test specimen (× 10). A few porous areas were noted in this section.



(*b*) Cross-section through gage length of round test specimen (× 10). The central portion of the specimen showed some evidence of porosity.

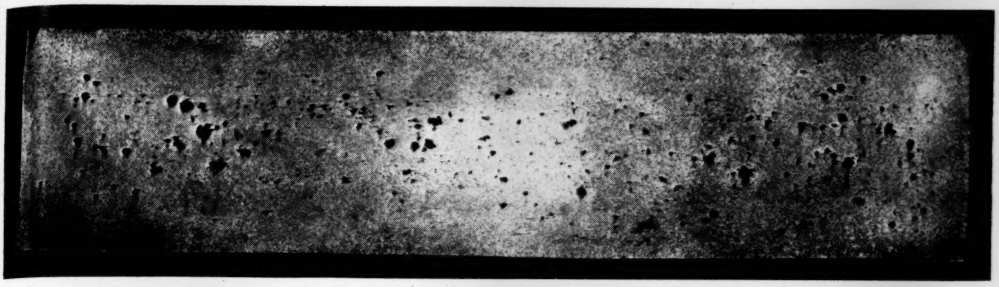


(*c*) Shows network of constituents probably composed of "T" (Cu-Ni), silicon, β (Fe-Si), α (Cu-Fe), (Cu-Fe-Mn) and (Mn-Si) (×50

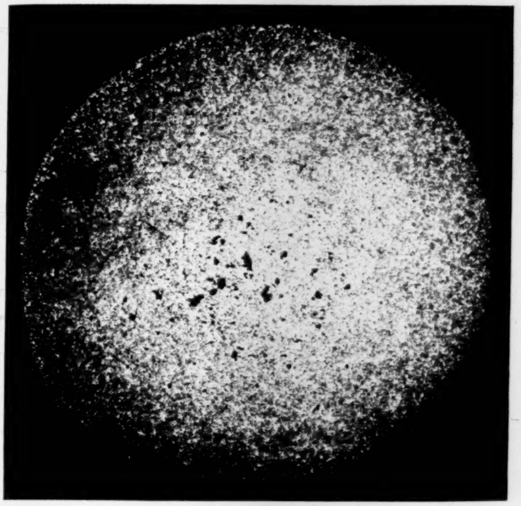
FIG. 6.—Macrographs and Micrograph of Specimens of Alloy No. VI. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

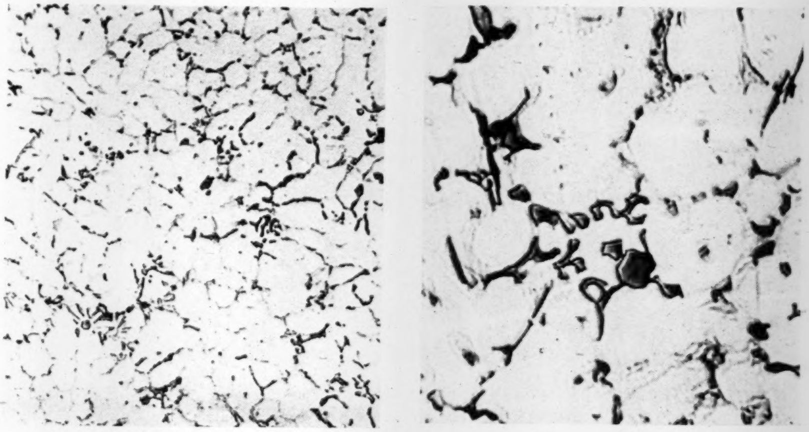
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
2.00	3.03	0.37	1.26	0.29	0.68	0.00	92.37



(*a*) Cross-Section through gage length of flat test specimen (× 10). This section contained a number of areas of porosity uniformly distributed.



(*b*) Cross-section through gage length of round test specimen (× 10). Shows some porous areas in the center of the section.



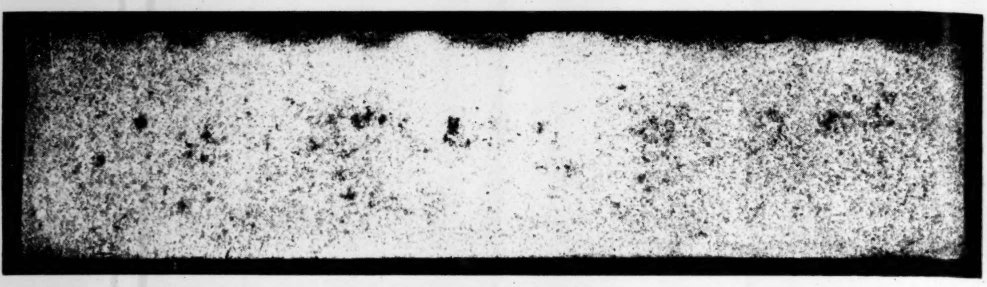
(*c*) Shows network of constituents in solid solution matrix (× 500).

(*d*) Shows constituents probably consisting of β (Cu-Fe), silicon (Cu-Fe-Mn) and β (Fe-Si) in solid solution matrix (× 1500).

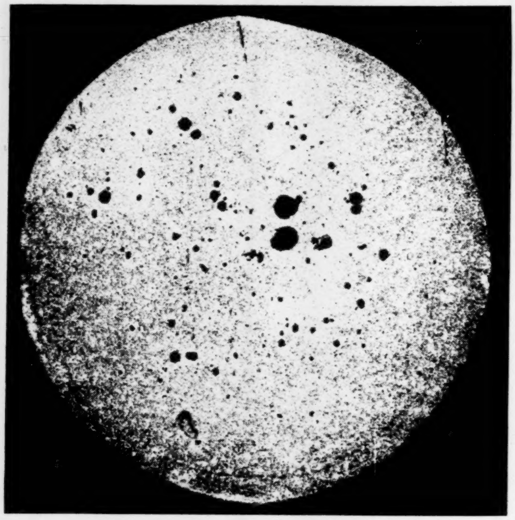
FIG. 7.—Macrographs and Micrographs of Specimens of Alloy No. VII. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

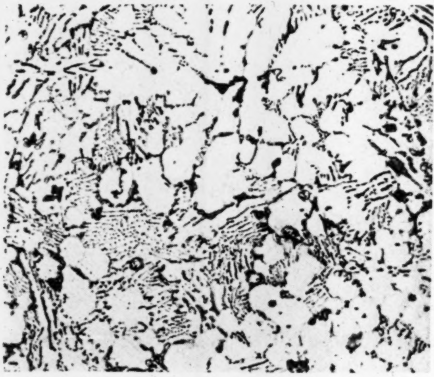
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
3.35	5.06	0.11	1.45	0.60	0.30	0.00	89.13



(*a*) Cross-section through the gage length of flat test specimen (× 10). A few areas of porosity were in evidence.



(*b*) Cross-section through the gage length of round test specimen (× 10). This section showed a number of areas of porosity.

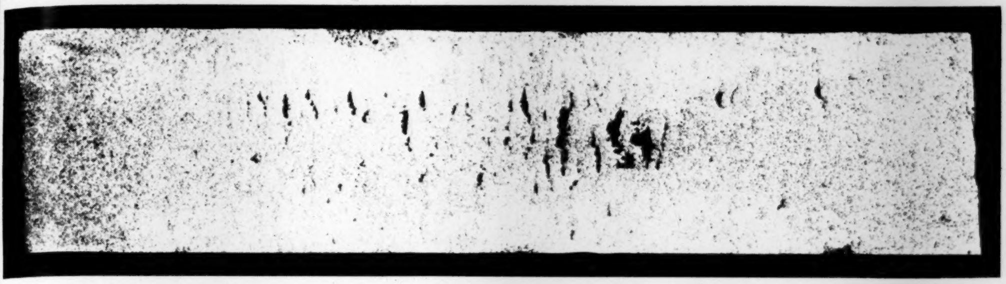


(*c*) Shows constituents probably consisting of "T" (Cu-Ni), areas of aluminum-$NiAl_3$ eutectic, α (Cu-Fe) and α (Fe-Si) in solid solution matrix (× 500).

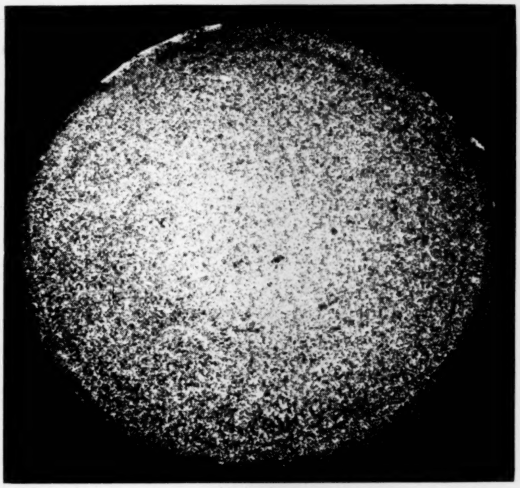
FIG. 8.—Macrographs and Micrograph of Specimens of Alloy No. VIII. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

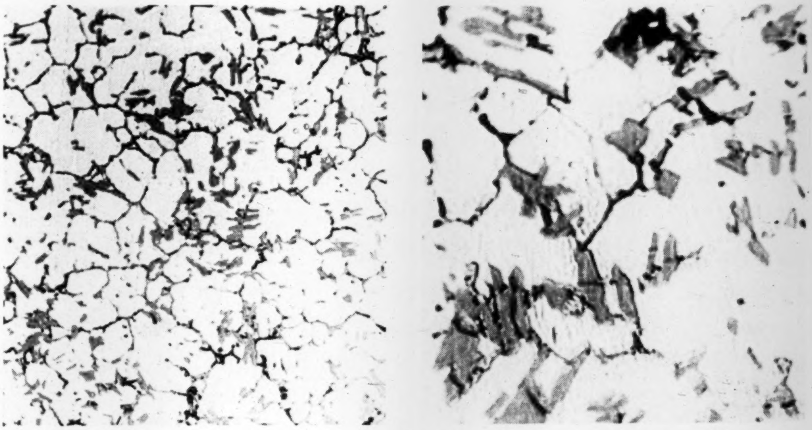
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
1.66	0.39	1.58	1.67	0.08	0.01	0.00	94.71



(a) Cross-section through the gage length of flat test specimen (× 10). This section had large porous areas in the central portion.



(b) Cross-section through the gage length of round test specimen (× 10). This section showed only a few small areas of porosity.



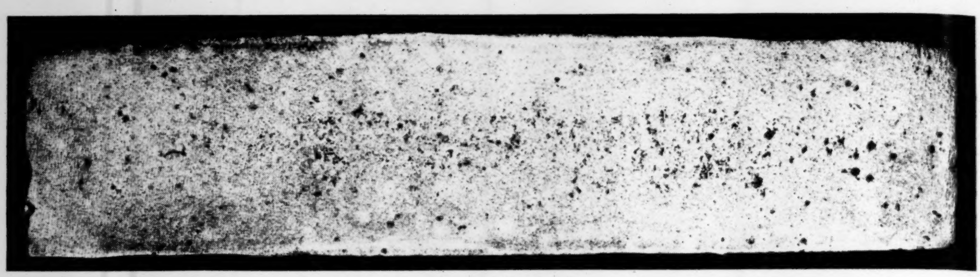
(*c*) Shows network of constituents in solid solution matrix (× 500).

(*d*) Shows network of constituents (× 1500). The "T" (Cu-Ni) constituent is the most prominent. The fine dark network is probably the (Cu-Fe-Mn) constituent.

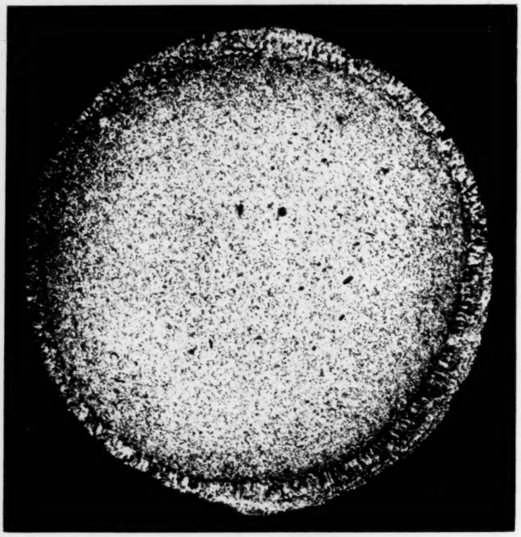
FIG. 9.—Macrographs and Micrographs of Specimens of Alloy No. IX. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

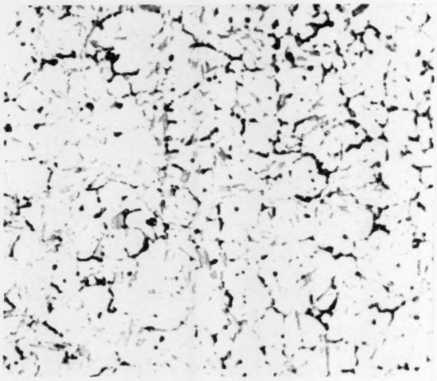
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
4.05	2.21	4.22	1.16	0.43	0.70	0.00	87.21



(*a*) Cross-section through gage length of flat test specimen (× 10). A number of areas of porosity may be seen distributed throughout the section.



(*b*) Cross-section through gage length of round test specimen (× 10). The zone of columnar grains around the outside of the section is a result of rapid cooling during solidification. A few areas of porosity were noted in the center of the section.

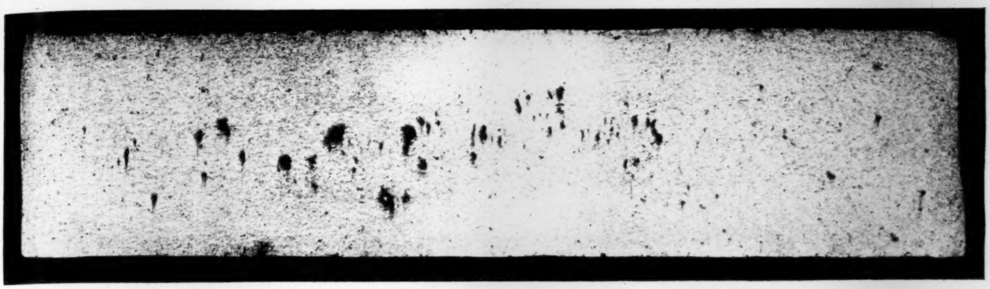


(*c*) Shows network of constituents in a solid solution matrix (× 500). The network probably contains $NiAl_3$, (Fe-Mn) and α (Fe-Si).

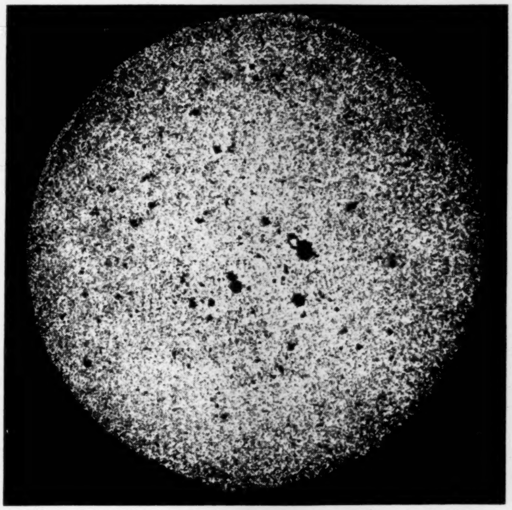
FIG. 10.—Macrographs and Micrograph of Specimens of Alloy No. X. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

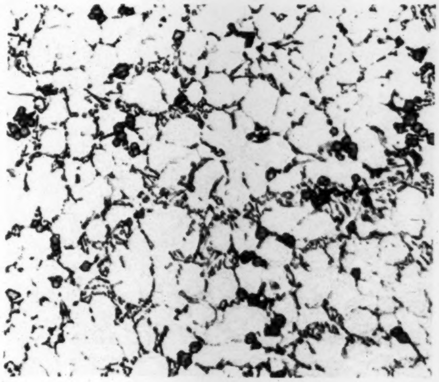
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
0.40	2.13	3.95	0.97	0.21	0.78	0.00	91.55



(*a*) Cross-section through gage length of flat test specimen (× 10). This section contained a number of areas of porosity.



(*b*) Cross-section through gage length of round test specimen (× 10). A number of areas of porosity are evident.

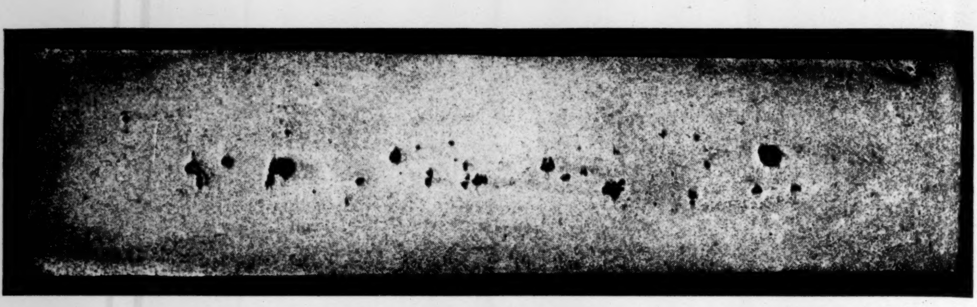


(*c*) Shows network of constituents probably composed of (Mn-Si), β (Fe-Si), silicon and areas of aluminum-silicon eutectic (× 500).

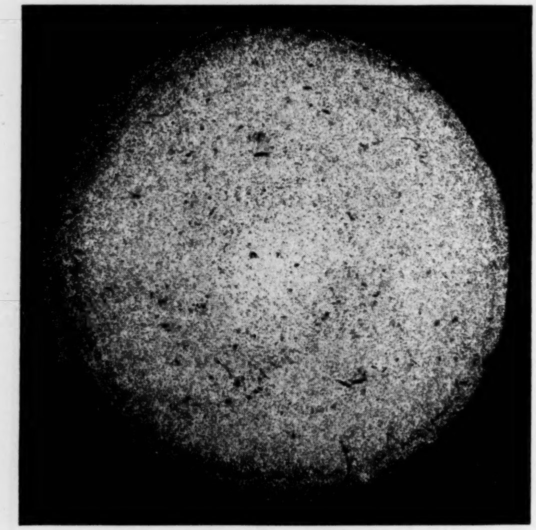
FIG. 11.—Macrographs and Micrograph of Specimens of Alloy No. XI. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

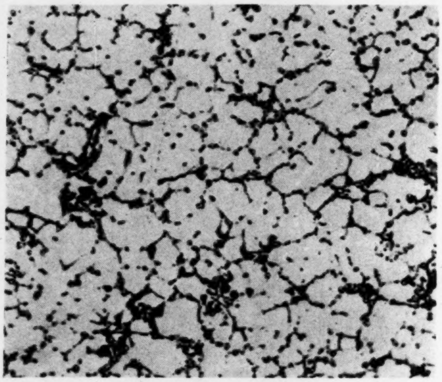
Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
1.85	7.71	0.31	0.92	0.20	0.77	0.00	88.25



(*a*) Cross-section through gage length of flat test specimen (× 10). Some large areas of porosity were noted in the central portion of the section.



(*b*) Cross-section through gage length of round test specimen (× 10). This section showed a zone of very fine grains around the outside and contained only a few small areas of porosity.



(*c*) Shows network of constituents probably made up of α (Cu-Fe), β (Cu-Fe), $CuAl_2$ and α (Fe-Si) (× 500).

FIG. 12.—Macrographs and Micrograph of Specimens of Alloy No. XII. Etching Reagent, HF-HCl-HNO_3.

ANALYSIS, PER CENT:

Copper	Silicon	Nickel	Iron	Zinc	Manganese	Tin	Aluminum, by difference
7.33	0.67	0.08	1.80	0.10	0.01	0.00	90.00

APPENDIX IV

RADIOGRAPHIC EXAMINATION OF DIE-CAST TEST BARS

By Ancel St. John[1]

At the meeting of Sub-Committee XV held at Philadelphia, October 10, 1928, Mr. Tobias, of the Newton Die-Casting Corporation exhibited X-ray photographs made by Herbert R. Isenburger, Inc., from die-cast test bars which he had submitted. As a result of the interest shown in these Mr. Isenburger offered on behalf of his organization to radiograph the sets of test bars which had been measured for density at the U. S. Bureau of Standards and found to be rather inconsistent.

Accordingly 120 test bars, one round and one flat bar each of twelve alloys made by five producers, were radiographed and the results reported briefly in December, 1928. These results were discussed at the meetings of the subcommittee in New York City on February 21, 1929, and at Chicago, March 20, 1929. They are reproduced in Figs. 1 to 5.

The interpretation of radiographs is not difficult. They are essentially shadow pictures formed by the passage of X-rays through materials having different transparencies to this sort of light. In the illustrations, therefore, differences in transparency will be due to one or more of the following causes: (a) differences in thickness with the same composition, as in the ends and test portions of round bars, (b) the identification marks on flat bars and (c) the obvious cavities in many bars, (d) to differences in composition with the same thickness, as in the various flat bars of alloys I to VI from different sources, or (e) to a combination of causes of items (c) and (d), as the flat bar of alloy III and the round bar of alloy IV.

Internal cavities thus always appear as light spots with characteristic and rather easily recognized forms. Inclusions may appear as light spots or dark spots depending upon their relative transparency. In general the transparency decreases as the atomic weight increases, hence the considerable variations in transparency of alloys I to XII.

The radiographs indicate the cause of the inconsistency in density measurements noted by the Bureau of Standards.[2] The actual mass of the material present is less than that corresponding to the measured volume in every case, hence every density is an "apparent density," smaller than the real value. In some cases the cavities constitute true porosity, that is a bubble or foam-like structure due to entrapped gases, as in the round bar XI, Fig. 1; in some cases they indicate pipe or hot shrinkage due to the contraction of the metal during or soon after freezing, as in the round bars IX and X, Fig. 3; in other cases, rupture or cold shrinkage due to excessive internal contraction during cooling, as in the flat bar I, Fig. 4. At times the porosity is of almost microscopic fineness, as in the flat bar VI, Fig. 4; or it may be associated with ruptures starting from gas cavities as in the flat bar II, Fig. 5. Segregation sometimes occurs as in the flat bar III, Fig. 2.

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[1] Consulting Physicist, Long Island City, N. Y.

[2] See p. 195.

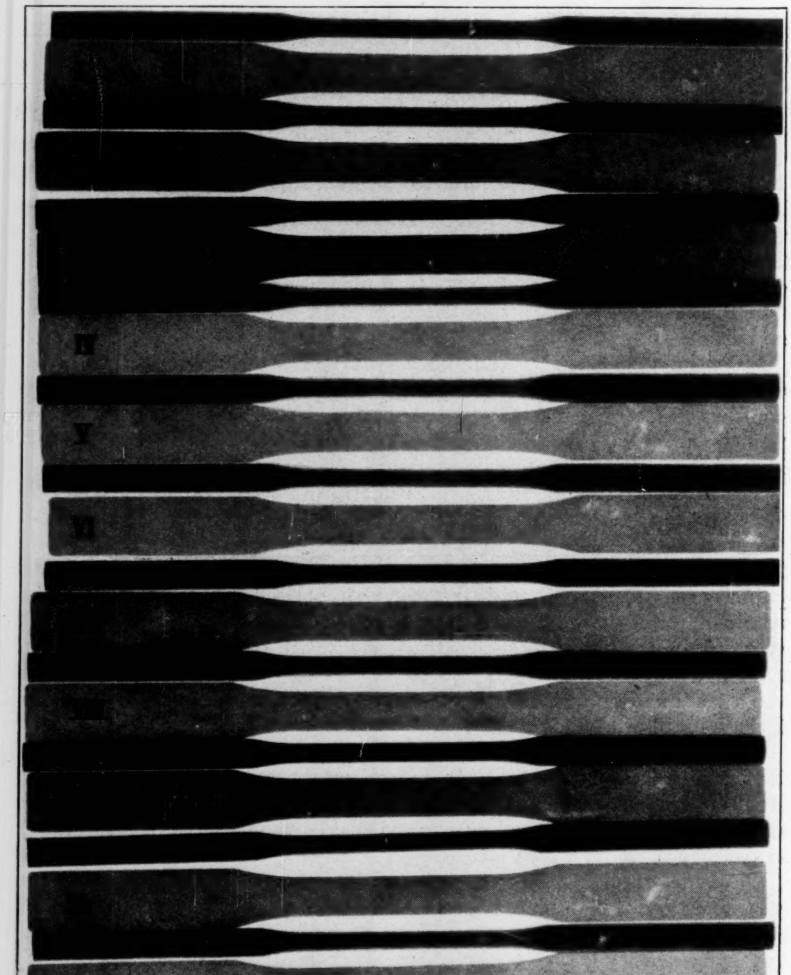

FIG. 1.—X-ray Photograph of Die-Casting Alloy Specimens (Round and Flat), Producer A, Alloys I to XII.

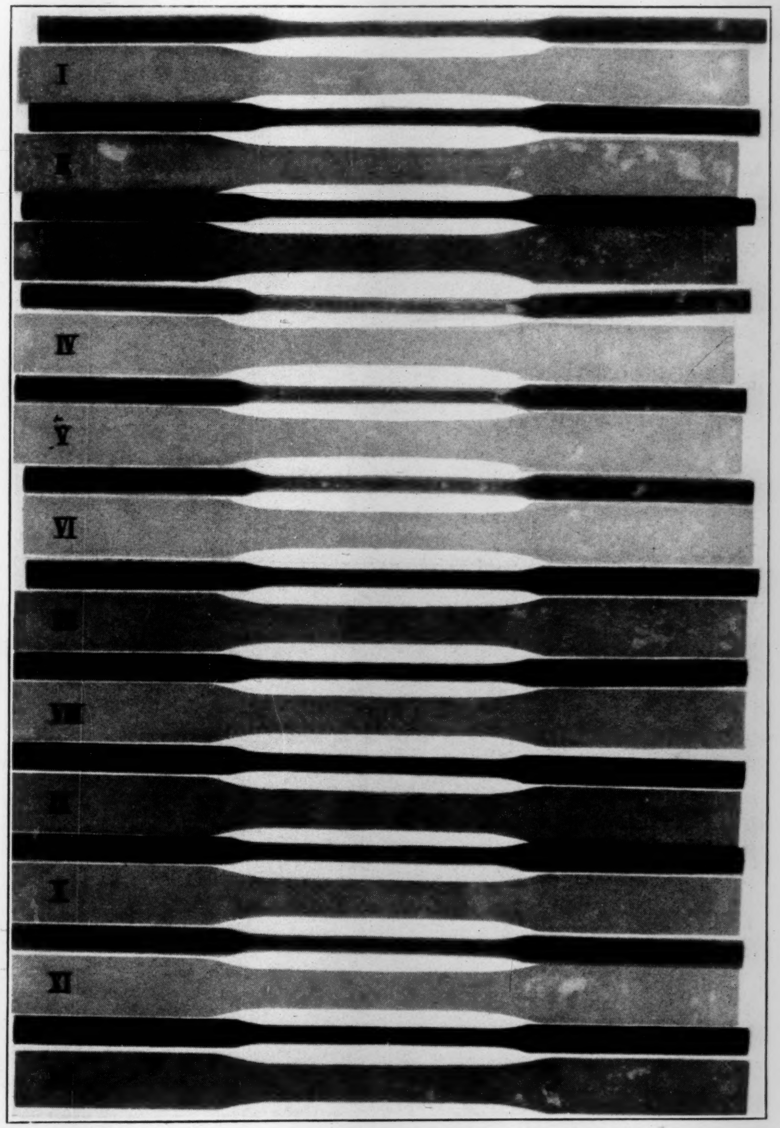

FIG. 2.—X-ray Photograph of Die-Casting Alloy Specimens (Round and Flat), Producer B, Alloys I to XII.

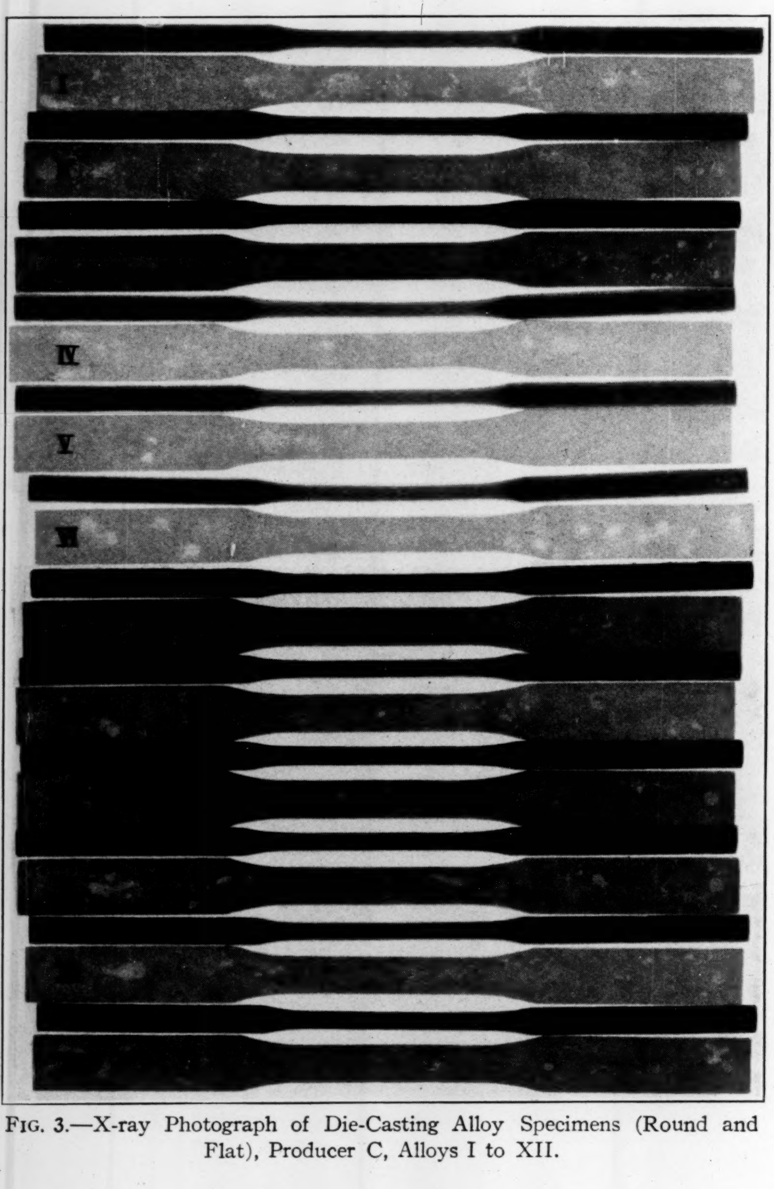

FIG. 3.—X-ray Photograph of Die-Casting Alloy Specimens (Round and Flat), Producer C, Alloys I to XII.

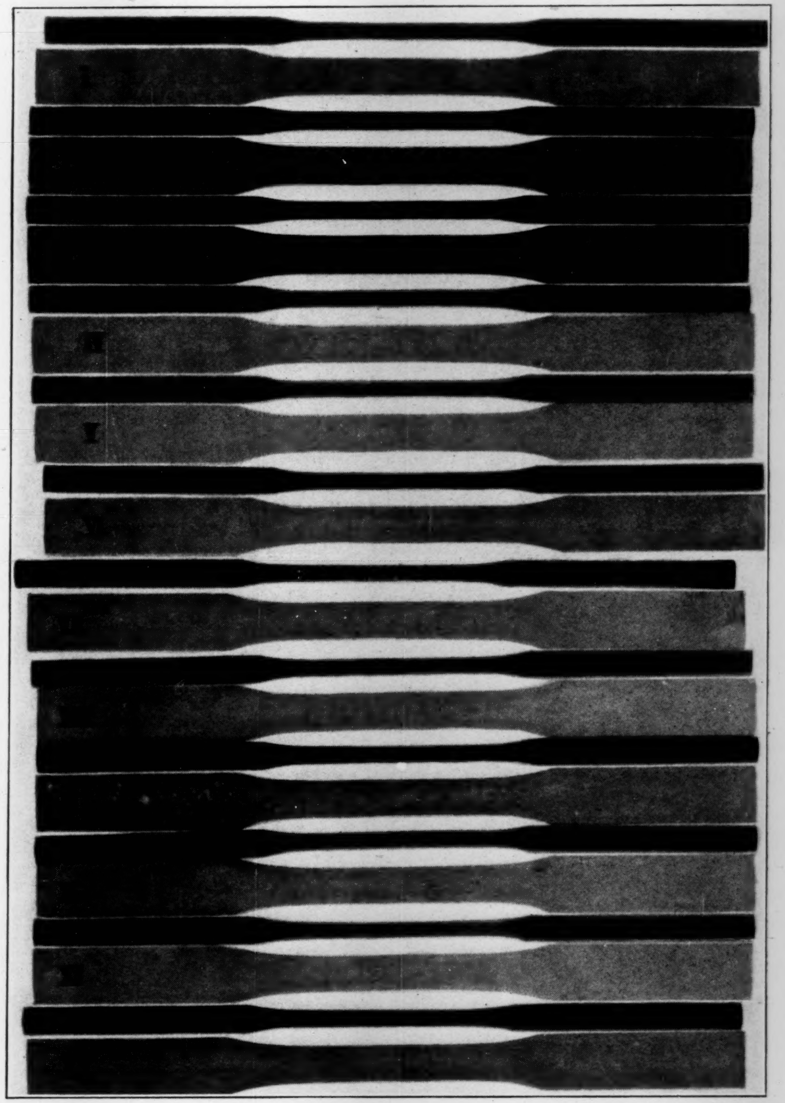

FIG. 4.—X-ray Photograph of Die-Casting Alloy Specimens (Round and Flat), Producer D, Alloys I to XII.

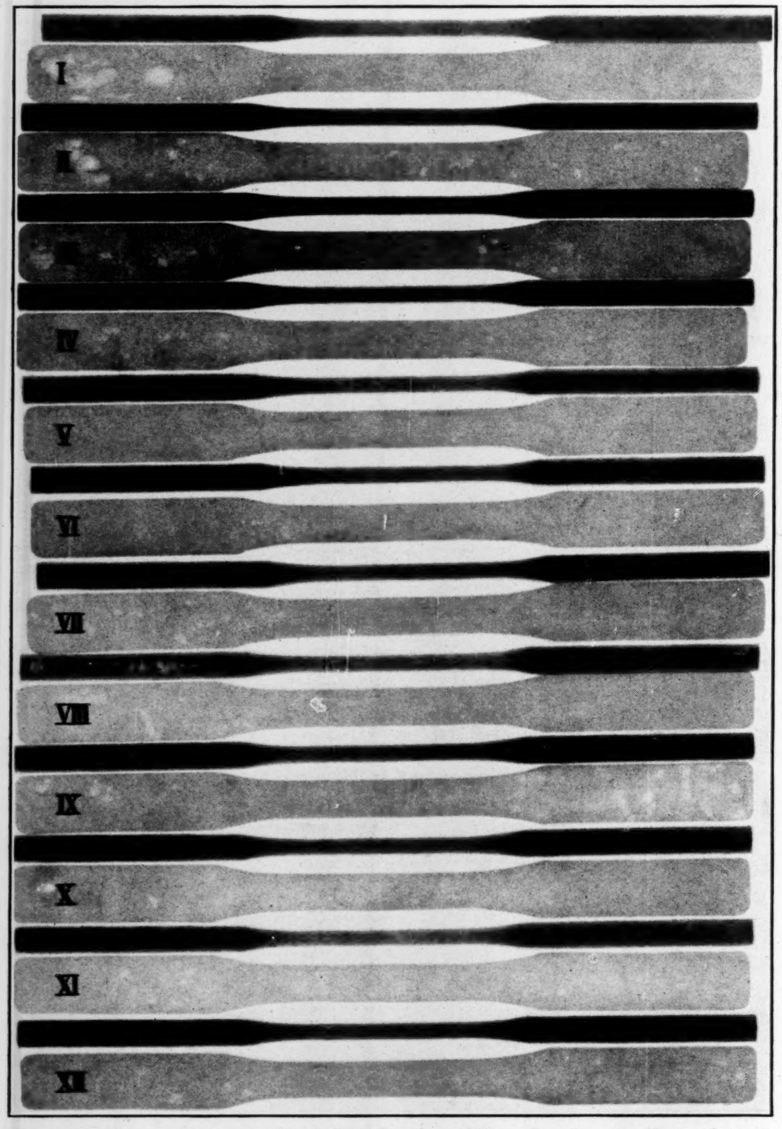
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII

FIG. 5.—X-ray Photograph of Die-Casting Alloy Specimens (Round and Flat), Producer E, Alloys I to XII.

The number of specimens examined has not been sufficient to warrant any conclusions as to the relative merits of the casting techniques used by the different producers, although each seems to show certain general tendencies. Rather than attempt to classify the individual bars as to quality it has seemed better to point out these tendencies. It is worth noting in this connection that practically all the round bars show some porosity or pipe along the axis, whereas many of the flat bars are sound throughout the test portion. The general conclusions are as follows:

Producer A (Fig. 1). Test portions generally sound; porosity with ruptures near the end of test portion in several flat bars.

Producer B (Fig. 2). Test portion of flat bars generally sound; round bars have considerable porosity and internal shrinkage.

Producer C (Fig. 3). General porosity often associated with fine ruptures; marked pipe in several bars.

Producer D (Fig. 4). Flat bars spongy or ruptured; round bars fairly sound.

Producer E (Fig. 5). Test portions generally porous, often with fine ruptures.

In attempting to assess the value of this sort of examination it must be remembered that finer details plainly visible in the negative are often lost in preparing the half-tone illustrations and that a final judgment should be based upon a study of the negatives. The illustrations however, do show that radiographic examination of cast test bars discloses information which can be secured in no other way, as to the actual existence and distribution of cavities, as to the probable value of the individual bars as representative of the properties to be measured, and as to the probable causes of such objectionable conditions.

In fully one-half the specimens defects which might, or indeed probably would, lead to premature breakage occur within the test portion. Experience has shown that conditions of this sort tend to be chronic for a given composition, die and casting technique. It is probable that specimens chosen for impact and tension tests would exhibit similar conditions. Whether the resulting test data would show the predicted correlation with the results of the X-ray examinations is an open question.

If the flat bar I, Fig. 3, were tested in a tension testing machine it would be likely to fail through one of the larger cavities; the cavity might be noted in the fracture and the test rejected. But if the flat bar I, Fig. 4, were tested it would probably fail through one of the transverse ruptures and it would be difficult if not impossible to recognize from the fracture that this rupture had been present. The test would be accepted and low strength, elongation and reduction of area values would be calculated. Flat bars like I, Fig. 5, and I, Fig. 1, would be apt to fail at the porous regions and the porosity is fine enough to escape detection in the fracture; the strength values would be lower than actually characteristic of that alloy but might very well be proper for the alloy and the casting technique used. The results suggest the desirability of radiographing a number of specimens before and after tension tests so as to determine what relations, if any, exist between the location and character of cavities and the location and character of necking, fracture, etc.

DISCUSSION

MR. HERBERT R. ISENBURGER[1] (*presented in written form*).—In his report on Radiographic Examination of Die-Cast Test Bars, Mr. St. John gives a complete statement of the work he and the writer have done for Sub-Committee XV on Die-Cast Metals. It may, however, be desirable to give some further information concerning work on die-cast metals and practical applications of radiography in this connection.

Two further sets of aluminum test bars, made by one of the manufacturers cooperating with the committee, were submitted through another source for X-ray examination. Figure 1 shows the flat and round bars and Fig. 2 the flat and square bars of alloys VII to XII. Unfortunately the prints here reproduced do not show all the details to be observed in the negative; but they do prove that the same characteristic defects in the flat bars show distinctly in both illustrations.

As a matter of fact, these interior defects depend largely on the construction of the die. These unsound conditions can be reduced to a minimum by the employment of radiographic examination. The study of radiographs will make it possible to change the form or position of gates and air vents so as to secure the correct flow of metal. With such proper casting procedure, the quality of die-casting products can be raised to perfection as will be seen in Fig. 3, which is a radiograph of the carburetor housing photographed in Fig. 4. This method of inspection is especially valuable before a new die is taken into production work.

As Mr. St. John has pointed out, the transparency to X-rays of a given character decreases with increasing atomic weight. Hence it is necessary to use rays of higher penetrating power for zinc-base alloys than for aluminum. The penetrating power increases with the voltage applied to the X-ray tube.

In practical routine inspection of aluminum die castings satisfactory details are obtainable with an X-ray outfit capable of operating at 100,000 volts peak. We have found a small valve tube equipment excellent for this purpose. For zinc-base castings it would probably be preferable to use equipment with a range up to 200,000 volts.

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[1] Herbert R. Isenburger, Inc., New York City.

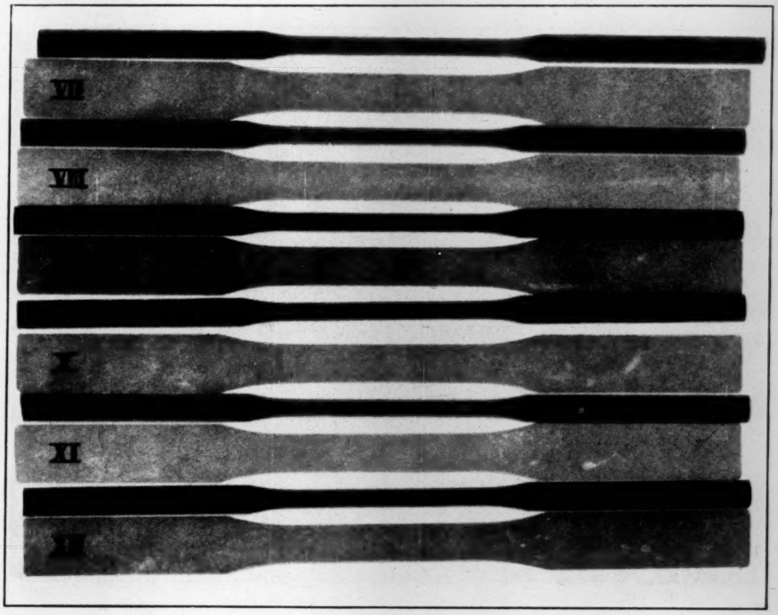

FIG. 1.—X-ray Photograph of Die-Casting Alloy Specimens (Flat and Round), Alloys VII to XII.

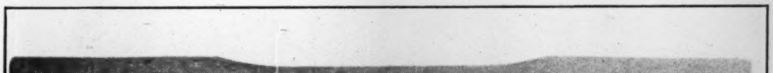

FIG. 2.—X-ray Photograph of Die-Casting Alloy Specimens (Flat and Square), Alloys VII to XII.

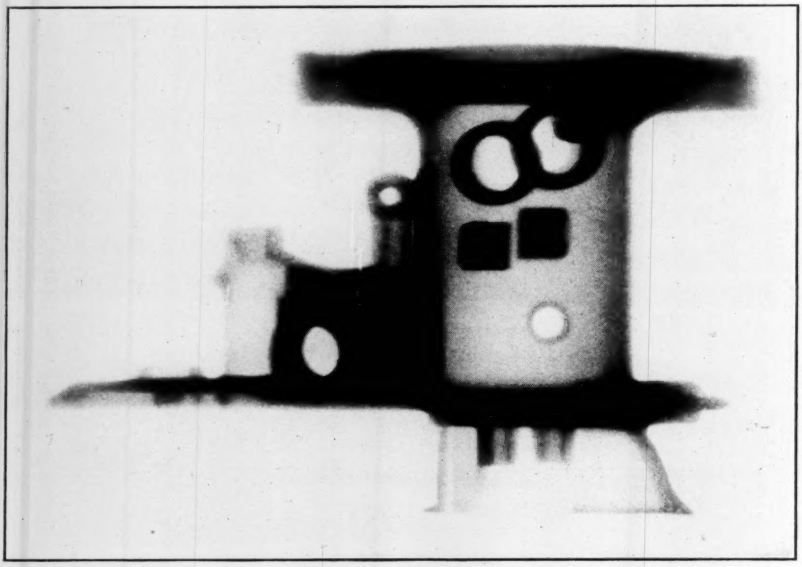

FIG. 3.—X-ray Photograph of Carburetor Housing.

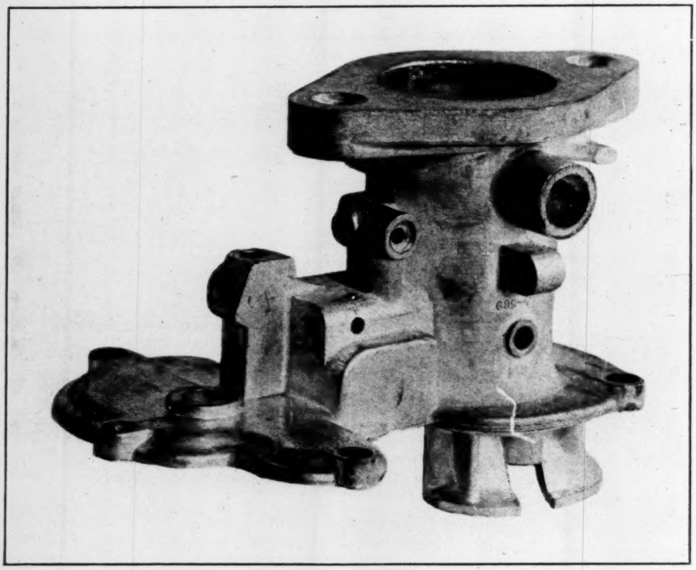

FIG. 4.—Photographic View of Carburetor Housing Shown in Fig. 3.

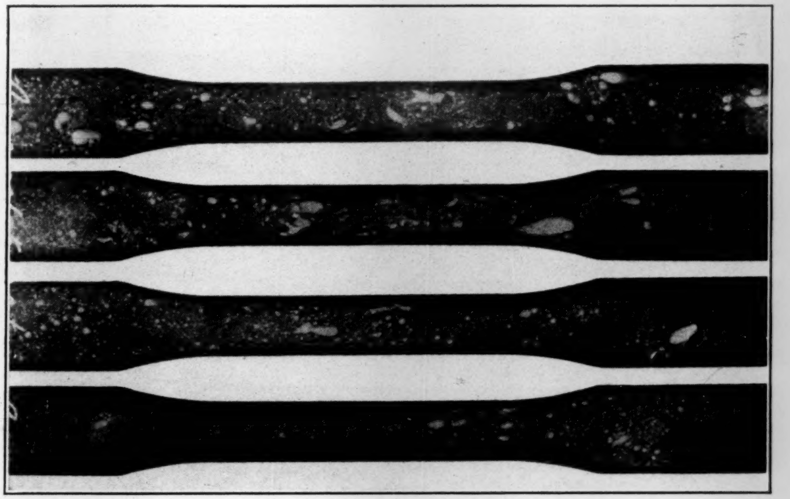

FIG. 5.—X-ray Photograph of Die-Casting Alloy Flat Specimens, Producer C, Alloy X.

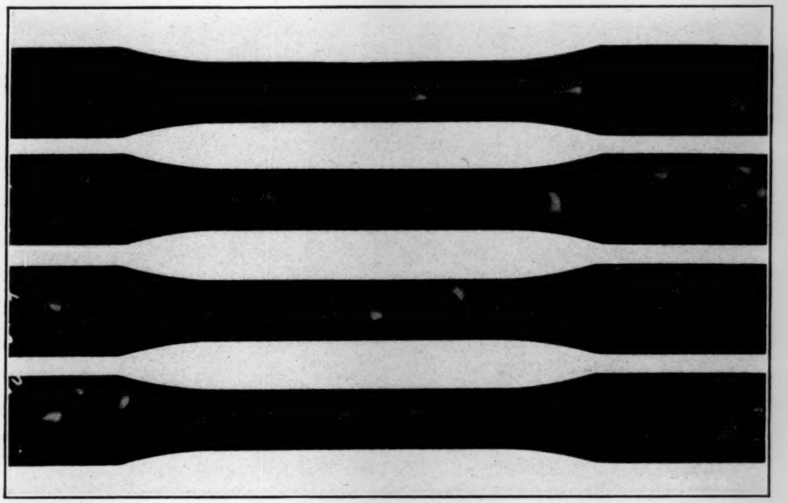

FIG. 6.—X-ray Photograph of Die-Casting Alloy Flat Specimens, Producer C, Alloy V.

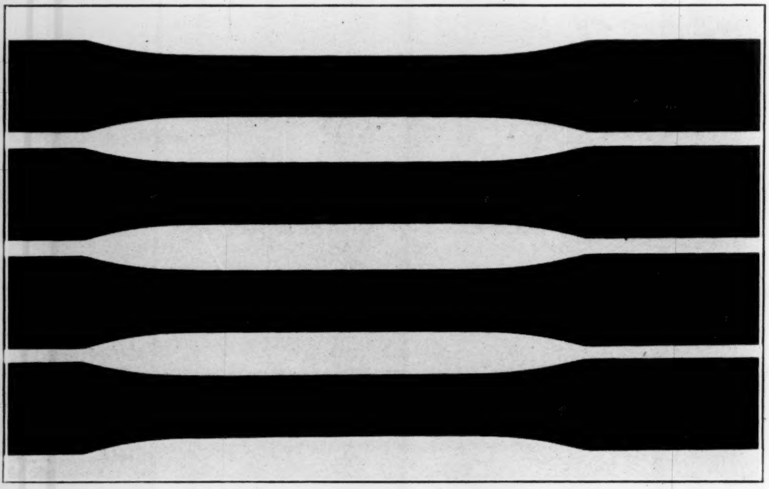

FIG. 7.—X-ray Photograph of Die-Casting Alloy Flat Specimens, Producer D, Alloy III.

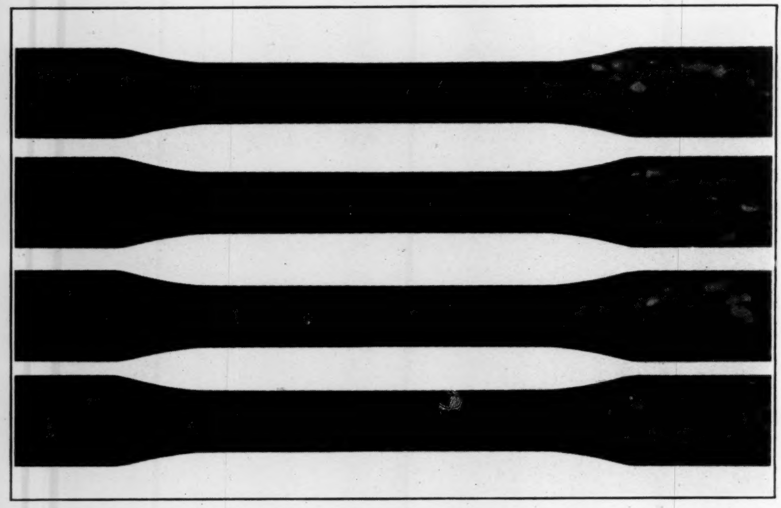

FIG. 8.—X-ray Photograph of Die-Casting Alloy Flat Specimens, Producer B, Alloy IV.

The appearance of the defects is almost the same for different metals and can be raised up to 1 per cent precision in radiography (photographic record) and up to 4 per cent in fluoroscopy (visual examination). This holds good for blow holes which lie in the direction of the rays.

Among other very important applications of X-ray examination in the die-casting field is the inspection of steel before expensive dies are made; and the fluoroscopic inspection of the entire output of castings which are to be supplied on the basis of a certain permissible porosity.

MESSRS. R. S. DEAN[1] AND J. L. GREGG[1] (*by letter*).—Radiographic examinations made at the Western Electric Co. of the flat tension test specimens of aluminum-base alloys have shown marked differences between samples of the same alloy cast by different producers. In this study, four specimens of each alloy cast by producers C and D were radiographed and four specimens of alloys IV and V from each of the other three producers.

All of the specimens cast by producer C contained numerous gas holes, some of which were over $\frac{1}{8}$ in. wide as is shown in Fig. 5. Of the series of alloys cast by this producer the specimens of alloy V, shown in Fig. 6, exhibited the least porosity while it was difficult to determine which alloys were the most porous.

The samples cast by producer D were almost free from the type of porosity just illustrated or the gas holes were very minute, but several of the alloys exhibited what appeared to be shrinkage cracks as shown in Fig. 7. Alloys I, II, III, IV, IX and XI were cracked as illustrated in Fig. 7.

Specimens of alloys IV and V, cast by producers A, B, and E, all contained some rather large gas holes, but in most instances these holes were near the ends of the specimens as is illustrated in Fig. 8.

From a comparison of these radiographic studies with the analyses of the alloys from the different producers, it appears that cracks found in specimens from producer D and the excessive porosity found in specimens from producer C must be due to differences in casting practice rather than to differences in composition. It is possible, however, that the soundness of the castings may be dependent upon undetermined impurities such as dissolved gases. In the absence of data on the casting technique used by the various producers, it is impossible at the present time to form any really definite conclusions as to the cause of the variations in soundness of the test specimens.

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[1] Metallurgical Engineer, Western Electric Co., Chicago, Ill.

REPORT OF COMMITTEE B-3
ON
CORROSION OF NON-FERROUS METALS AND ALLOYS

During the past year, Committee B-3 has been active through its Advisory, Finance, and various sub-committees.

The U. S. Bureau of Standards has agreed to act as storekeeper of the test materials to be used in the corrosion tests on non-ferrous metals being undertaken by the committee. The committee will pay all charges for crating and transportation, and the Bureau will sort and weigh the specimens on a balance supplied by the committee. Specimens will be stored in containers supplied by the committee.

Approximately $9500 has been subscribed to the fund for carrying on the corrosion work planned by this committee in cooperation with Sub-Committee XV on Die-Cast Metals and Alloys of Committee B-2 on Non-Ferrous Metals and Alloys. The solicitation of funds is being continued and it is hoped that a total of at least $10,000 will be raised so that $7500 will be available for Committee B-3 and $2500 for the work of Sub-Committee XV of Committee B-2.

Sub-Committee I on Total Immersion Test (H. A. Bedworth, chairman).—This sub-committee has been inactive during the past year as the personnel is working with Sub-Committees VI, VII and VIII in getting the main program of corrosion tests of Committee B-3 under way. When the main program is under way, Sub-Committee I will again resume activity in carrying out total-immersion laboratory tests to parallel the outdoor exposure tests and service tests of the above sub-committees.

Sub-Committee II on Alternate Immersion Test (D. K. Crampton, chairman).—This sub-committee has been inactive for the past year due to the fact that most of the members are also members of the other sub-committees dealing with long-time tests. At present most of the interest is centered on these long-time tests and after they are well under way this sub-committee expects to again work on the alternate immersion test.

At present two of the laboratories are carrying on considerable work on the alternate-immersion test, more or less on their own initiative, and have taken precautions to prevent considerable trouble which led to unsatisfactory results in the committee work as a whole on the first series of tests. It is felt that the test when properly controlled is a very valuable one and the following precautions when observed, in addition to the original recommendations,[1] will give satisfactory results:

1. It is highly essential that the temperature of the solutions be maintained constant. It is perhaps not so important just what this temperature is, as that it be constant and recorded. One of the laboratories is using a temperature of 60° C. and the other 40° C.

2. As originally laid out the test did not take into account any control of the drying of the samples when out of solution. It is felt that it is highly essential that the samples either be promptly and thoroughly dried, or kept continuously wet. There are, possibly, advantages for both of these schemes, but the indeterminate condition of uncontrolled drying must be avoided.

3. Steps should be taken to avoid changing concentration of the solution:

   (*a*) Due to impoverishing the solution as a result of chemical reaction.

   (*b*) Due to volatility of the solute.

4. All tests should be run a sufficient length of time to get a reliable indication of the relative merits of the materials used. With any metal-solution combination which would be commercially practicable, a time of test of 60 days or more is considered essential.

5. The apparatus should be arranged so that all samples should enter the solution at precisely the same part of the cycle.

Sub-Committees III, IV, and V have been inactive during the past year due to all members being very busy in connection with the work of Sub-Committees VI, VII, and VIII.

Sub-Committee VI on Atmospheric Corrosion (W. H. Finkeldey, chairman).—The galvanized structural steel test racks ordered from Riter-Conley Co. have been fabricated and delivered to the various test locations. Arrangements have been completed with the Navy Department at Key West, the Rochester Gas and Electric Co., at Rochester, N. Y., the Pennsylvania Railroad Co., Altoona, Pa., and the Bell Telephone Laboratories, in New York City, to erect the test racks in these locations without expense to the committee. This work has already been completed at Altoona, and at the Bell Telephone Laboratories in New York City. The erection of the Key West rack is now in progress and the rack at Rochester will be started as soon as the weather permits. The other test racks at Sandy Hook, N. J., State College, Pa., and Pittsburgh, have been erected under the supervision of the field superintendent of the Page Steel and Wire Co.

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[1] See 1927 Report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys, *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 281 (1927).

An order has been placed with the Diamond Expansion Bolt Co. for the small test racks of Sub-Committees VI and VIII of Committee B-3 and of Sub-Committee XV of Committee B-2. These test racks should be completed and delivered to the various locations during April and May in ample time to receive the test specimens now being collected by Mr. Christie.

One change has been made in the list of alloys to be tested, "chemical lead" having been substituted in place of the so-called "commercial lead." An additional metal has been added to the list in the form of a very pure grade of zinc which will analyze over 99.994 per cent. This addition brings the total number of metals and alloys to be tested to 24, completely filling the test racks.

Sub-Committee VII on Corrosion in Liquids (R. J. McKay, chairman).—The outline of proposed tests of this sub-committee as set forth in the annual report for 1928[1] remains unchanged. As soon as the necessary test specimens are supplied, actual testing will be begun.

Sub-Committee VIII on Galvanic and Electrolytic Corrosion (A. E. Flowers, chairman).—The facilities for carrying out the program of this sub-committee as outlined in the annual report for 1928[1] are now largely ready and work will go forward as soon as the materials to be tested are received.

Mr. J. L. Christie has been acting as a sub-committee on samples. During the past year the exact and detailed metal requirements for each of the three sub-committees performing exposure tests and the four original sub-committees which are to perform accelerated tests have been correlated, classified, and sent to the various mills that have offered to supply the materials.

There are 33 distinct materials involved, supplied by 13 separate mills on 104 purchase orders. The materials consist of 12,250 tension test specimens and 9750 specimens for exposure, accelerated tests and a reserve supply for miscellaneous purposes.

It is expected that these materials will all be ready for delivery shortly. Arrangements have tentatively been made for the machining of the tension test specimens.

This report has been submitted to letter ballot of the committee, which consists of 38 members; 32 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

T. S. FULLER,
Chairman.

SAM TOUR,
Secretary.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 223 (1928).

REPORT OF COMMITTEE B-4
ON
HIGH-TEMPERATURE AND ELECTRICAL-RESISTANCE ALLOYS

Two meetings of the committee have been held during the past year, as follows: On November 12 and 13, 1928, at Washington, D. C. and on February 18 and 19, 1929, at New York City.

Six members have been added to the committee during the year and two have resigned, leaving the total membership 23, classified as 12 non-producers, 9 producers and 2 general interests.

Recommendations Affecting Standards and Tentative Standards

Proposed Tentative Accelerated Life Test for Metallic Materials for Electrical Heating.—A test to determine the durability of electrical heating wires at operating temperatures, as appended hereto,[1] is recommended for publication as a tentative standard. This method covers the determination of the resistance to oxidation at high temperatures under intermittent heating of metallic materials for electrical heating. The method is applicable to two general classes of metallic materials for electrical heating, as follows: Class A, alloys suitable for commercial service up to 1100° C. (2012° F.) and Class B, alloys suitable for commercial service up to 900° C. (1652° F.).

The specimen having nominal diameter from Nos. 20 to 22 A.w.g. is intermittently heated by electric current with a cycle of two minutes on and two minutes off, under constant voltage conditions. The intermittent test corresponds to intermittent service of various household electrical heating appliances. The temperature of the specimen is measured by an improved form of optical pyrometer. The life obtained with the intermittent test is much shorter than with continuous heating at the same temperature.

The specimen is mounted vertically, dipping into a mercury cup at the bottom to provide for expansion, and is kept straight by a small weight suspended from it. Vertical and horizontal catenary mounting were compared and the vertical mounting was found to be more convenient and also avoided the temperature variations obtained when horizontal specimens were mounted above each other.

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[1] See p 613.—Ed.

In order to obtain consistent results it has been found necessary to closely control the voltage and the initial temperature of the specimen and also to shield the specimen from draughts of air.

Tests were made with the current cycle off-and-on periods varying from ten minutes on and five minutes off to 30 seconds on and 30 seconds off, and it was found that the cycle of two minutes on and two minutes off gave the shortest life for a given temperature. It appears that the time for cooling has to be sufficient to permit the specimen to reach a low enough temperature to cause any loosening or cracking of scale which will occur due to variations in coefficient of expansion of the scale and the metal.

Life tests were made on a typical Class A alloy of 80 per cent nickel and 20 per cent chromium and on a typical Class B alloy of 60 per cent nickel, 15 per cent chromium and 25 per cent iron in three different laboratories in accordance with the proposed methods. The results obtained were as follows:

	NUMBER OF TESTS	AVERAGE HOURS OF LIFE	AVERAGE DEVIATION, PER CENT
	CLASS A ALLOY		
Laboratory A	4	115.5	±7.0
Laboratory B	4	106.4	±3.8
Laboratory C	8	118.7	±8.0
	Average	114.8	
	CLASS B ALLOY		
Laboratory A	4	112	±1.8
Laboratory B	4	110	±7.8
Laboratory C	4	114	±1.3
	Average	112.3	

Tentative Method of Test for Resistivity of Metallic Materials for Electrical Heating (B 63 - 26 T).[1]—It is recommended that this method of test be revised to include a method for the determination of density, to be used when it is desirable to use the density method for determining the cross-section of the specimen. It is also recommended that the title be changed in order to allow application of the method to any electrical resistance materials instead of limiting it to electrical heating materials. With the following modifications the method is recommended for submission to letter ballot of the Society for advancement to standard:

Title.—Change to read as follows by the addition of the italicized word and the omission of the words in brackets:

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 738 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 166.

Tentative Method of Test for Resistivity of Metallic Materials for [Electrical Heating] *Resistors*.

Section 5.—Add the following at the end of this section:

When the density is unknown, it may be determined by weighing a sample of at least 10 g. first in air and then in water. The density in grams per cubic centimeter is equivalent to the weight in air divided by the loss of weight in water. The water shall be at room temperature to avoid errors due to convection currents. For the accuracy required no corrections are necessary for the temperature of the water or for the buoyancy of the air. However, care shall be exercised to remove all air bubbles from the sample when weighing it in water. To remove air bubbles from a sample of fine wire, the sample, in the form of a loosely wound coil, shall be dipped in alcohol and rinsed in water before immersing to make the weighing in water.

Section 8.—Add a note at the end of this section to read as follows:

NOTE.—The resistivity of a material usually depends on its previous mechanical and thermal treatments. Wherever possible these shall be stated in the records of the test.

Tentative Methods of Chemical Analysis of Metallic Materials for Electrical Heating (B 71 - 28 T).[1]—It is recommended that these methods of chemical analysis be revised by the addition of procedures for determinations of copper in nickel-copper alloys containing from 10 to 90 per cent of copper and in alloys of chromium with iron or nickel or both containing copper up to 5 per cent. The proposed procedures are appended hereto.[2] It is recommended that this revision be accepted and the methods as revised continued as tentative.

The proposed methods have been tried in three laboratories with the following results:

LABORATORY	NICKEL-COPPER ALLOY, COPPER, PER CENT	NICKEL-CHROMIUM ALLOY, (80 NICKEL 20 CHROMIUM), COPPER, PER CENT
No. 1	53.50[a]	0.143[b]
No. 2	53.46[b]	0.155[b]
No. 3	53.42[c]	0.139[c]
Lowest individual result	53.42	0.130
Highest " "	53.51	0.156
Average result of all determinations	53.46	0.146

[a] Average of four determinations.

[b] Average of three determinations.

[c] Result of a single determination.

GENERAL COMMITTEE ACTIVITIES

When Committee B-4 was organized, it was decided to begin with the work on metallic materials used in electrical heating and that other lines of work such as the study of electrical resistance materials would be deferred until a later date. In April, 1928, it was thought that sufficient progress had been made with the electrical heating materials to allow the broader range of work to be undertaken. The matter was taken up with the Executive Committee of the Society and after due consideration the scope of the committee was enlarged to include the field of electrical-resistance materials and the title changed to read "Committee B-4 on High-Temperature and Electrical-Resistance Alloys." The relation of the committee's work to that of the recently organized Committee A-10 on Iron-Chromium, Iron-Chromium, Nickel and Related Alloys is being considered jointly by the two committees and the Executive Committee of the Society.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 799 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 189.

[2] See p. 593.—ED.

TABLE I.—RESULTS OF TESTS ON RESISTIVITY OF NICHROME AND CHROMEL WIRES.

Designation	Approximate Length of Test Specimen, m.				Resistivity at 25° C., microhm-centimeters			
	Nichrome IV	Nichrome	Chromel A	Chromel C	Nichrome IV	Nichrome	Chromel A	Chromel C
$\frac{1}{32}$ by 0.005 in....	4.2	3.8	5.0	4.8	104.65	109.55	108.5	113.0
$\frac{1}{16}$ by 0.005 in...	3.3	3.8	5.0	5.0	105.15	109.65	108.35	113.0
$\frac{1}{8}$ by 0.005 in.....	3.9	3.9	4.9	4.9	105.35	109.6	108.1	112.75
$\frac{1}{8}$ by 0.010 in.....	4.0	4.4	4.0	4.7	104.8	109.75	108.0	112.8
$\frac{1}{8}$ by 0.032 in.....	3.7	3.5	2.8	2.8	106.0	109.7	108.1	112.7
$\frac{1}{8}$ in............	0.9	0.9	0.9	0.9	102.65	108.9	108.45	113.3
$\frac{1}{4}$ in............	0.9	0.9	0.9	0.9	104.5	109.65	108.4	112.9
No. 22..........	4.7	4.4	4.9	5.0	103.8	109.85	108.25	112.15
No. 30..........	4.4	4.6	5.0	5.0	103.35	110.1	108.55	111.9

The committee has made arrangements to carry on this work. Experimental work has been under way for six months to develop a method of test for the elastic properties of alloys at temperatures from 500 to 1000° C. The work has not yet been completed but promising results have been obtained. Steps have been taken to secure several new members interested in alloys for mechanical applications at temperatures over 500° C. so that the committee will be fully representative of the industry. Four new members, particularly interested in electrical resistance alloys have been secured, in order to provide a representative group in this field.

The sub-committees have been reorganized to include the broader scope of the committee and now are as follows:

Sub-Committee I on Life Tests. To determine durability under service conditions.

Sub-Committee II on Electrical Tests.

Sub-Committee III on Chemical Tests.

Sub-Committee IV on Mechanical Tests.

The former Sub-Committee on Physical and Electrical Tests was divided into Sub-Committees II and IV. The Sub-Committee on Standard Sizes and Packages has completed its work and has been discharged. The Sub-Committee on Application Data has been discharged, as it was not advisable to take up this subject at present.

Temperature Coefficient.—A section has been organized to work out a method for determining the temperature coefficient of resistance materials.

Thermal e.m.f.—A section has been organized to prepare a method of test for thermal *e.m.f.* against copper, for meter shunt materials.

Density and Electrical Resistivity.—At the request of the committee tests were made by the U. S. Bureau of Standards to determine the effect of the size of wire or ribbon upon the density and electrical resistivity. The samples were furnished by the Hoskins Manufacturing Co. and the Driver-Harris Co., all sizes of each grade of alloy being made from the same lot of material. The results secured, given in the accompanying Tables I and II, indicate that density and resistivity do not vary with size.

TABLE II.—RESULTS OF TESTS ON DENSITY OF NICHROME AND CHROMEL WIRE.

DENSITY AT 20° C., G. PER CU. CM.

Diameter of Wire	Nichrome IV	Nichrome	Chromel A	Chromel C
$\frac{1}{8}$ by 0.032 in	8.345	8.197	8.402	8.233
$\frac{1}{8}$ by 0.010 in	8.372	8.218	8.407	8.231
$\frac{1}{8}$ by 0.005 in	8.344	8.187	8.403	8.233
$\frac{1}{16}$ by 0.005 in	8.346	8.176	8.387	8.226
$\frac{1}{32}$ by 0.005 in	8.328	8.184	8.396	8.227
$\frac{1}{8}$ in	8.377	8.209	8.403	8.220
$\frac{1}{4}$ in	8.376	8.214	8.408	8.226
No. 22	8.362	8.198	8.405	8.230
No. 30	8.353	8.145	8.394	8.223

NOTE.—Check observations gave in practically all cases values consistent to ±0.002 g. per cu. cm. in density.

The Chromel samples were all heated together and slowly cooled, while the Nichrome samples were supplied as normally produced. Since the normal process is a quench from varying temperatures, depending upon the size, the variations in resistivity between the samples of Nichrome and between the Nichrome and the Chromel were of the magnitude of the variation in the data on the effect of quenching, previously submitted to the committee.

Temper.—A method of test has been outlined for testing wire and ribbon to determine the uniformity of stretch when wound into helical coils. A test coil is wound under uniform conditions, and is stretched until it has acquired a permanent set. The variation in the pitch of the helix indicates the uniformity of the wire. This method is being tried in several laboratories.

Label Colors.—Several manufacturers indicate the grade of electrical heating and electrical resistance wires by the color of the label on the spool of wire, but different colors for the same grade of wire are used by different manufacturers.

The standardization of colors has been taken up with various wire manufacturers and the following list of colors has been agreed upon:

MATERIAL	COLOR OF LABEL
80 per cent nickel, 20 per cent chromium	yellow
85 per cent nickel, 15 per cent chromium	white
Nickel-chromium-iron	red
55 per cent copper, 45 per cent nickel	pink
70 per cent copper, 30 per cent nickel	blue
Nickel steel, low chromium	lavender
Pure nickel	green
Manganese nickel	salmon pink
Monel metal	orange

These color requirements will be incorporated in specifications for the materials when such specifications are prepared.

The list of colors is being forwarded to the Division of Simplified Practice of the Department of Commerce for its information.

Spool Sizes.—The dimensions of spools used for electrical heating and electrical resistance wires by the various manufacturers were nearly the same, but differed in some respects. Standard sizes of spools were desirable both from the standpoint of manufacturers and users of wire.

The following dimensions of spools have been agreed upon by the committee and will be incorporated in specifications for wire when such specifications are prepared:

	SPOOL DIMENSIONS			
WEIGHT OF WIRE, LB.	DIAMETER OF FLANGE, IN.	TRAVERSE, IN.	DIAMETER OF HOLE, IN.	DIAMETER OF BARREL, IN.
1	2	3	⅝	1¼
2	2¾	3	⅝	1½
5	4	3	⅝	1½
10	6	3	⅝	1¾

The list of spool sizes is being forwarded to the Division of Simplified Practice of the Department of Commerce for its information.

Cross-Section of Ribbon.—A study has been made of the cross-section of nickel-chromium ribbon having rounded edges, determining the area accurately by the specific gravity method. It has been found that the actual cross section is less than the nominal cross-section (nominal width multiplied by nominal thickness) by an amount which varies with the ratio of width to thickness. Correction factors for determining cross-section from the nominal dimensions have been worked out and are being checked against data from production records.

The recommendations in this report have been submitted to letter ballot of the committee, which consists of 23 members, with the following results:

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARD			
1. Proposed Tentative Accelerated Life Test for Metallic Materials for Electrical Heating	18	0	5
II. PROPOSED REVISION OF TENTATIVE STANDARD			
2. Tentative Methods of Chemical Analysis of Metallic Materials for Electrical Heating (B 71 - 27 T)	18	0	5
III. ADVANCEMENT OF TENTATIVE STANDARD TO STANDARD			
3. Tentative Method of Test for Resistivity of Metallic Materials for Electrical Heating (B 63 - 26 T)	18	0	5

This report has been submitted to letter ballot of the committee, which consists of 23 members; 18 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

DEAN HARVEY,
Chairman.

F. E. BASH,
Secretary.

EDITORIAL NOTE

The proposed Tentative Accelerated Life Test for Metallic Materials for Electrical Heating was accepted for publication as tentative and appears on page 613.

The proposed revision of the Tentative Methods of Chemical Analysis of Metallic Materials for Electrical Heating was accepted. The tentative methods in their revised form appear on page 593.

The Tentative Method of Test for Resistivity of Metallic Materials for Electrical Heating was approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appears in the 1929 Supplement to Book of A.S.T.M. Standards, page 117.

REPORT OF COMMITTEE B-5
ON
COPPER AND COPPER ALLOYS, CAST AND WROUGHT

Committee B-5 is the outgrowth of the reorganization of the Society's Committee B-2 on Non-Ferrous Metals and Alloys. Its personnel consists of the personnel of the former Sub-Committees II and III of Committee B-2, these two sub-committees having been taken over in their entirety, becoming Sub-Committee I on Wrought Metals and Alloys and Sub-Committee II on Sand-Cast Metals and Alloys, respectively, of the new Committee B-5. Messrs. W. R. Webster and N. K. B. Patch, respectively, have been continued as the chairmen of these two sub-committees.

An organization meeting of Committee B-5 was held in New York City on February 19, 1929, at which meeting Mr. C. H. Mathewson was elected chairman and Mr. N. L. Mochel, secretary. In view of the way in which the committee was organized a membership somewhat unbalanced in its distribution between producers and non-producers resulted, a condition which will be overcome as the committee develops. Owing to the comparatively recent organization of the committee there has not been time for the development of plans and policies. A number of recommendations, however, affecting the standards under the jurisdiction of the committee are offered as indicated below.

Advancement to Standard of Tentative Revisions of Existing Standards:

The committee recommends that the tentative revisions of the following five standards, as proposed in 1927[1] and in 1928,[1] be advanced to standard:

Standard Specifications for Cartridge Brass (B 19 – 19);
Standard Specifications for Cartridge Brass Disks (B 20 – 19);
Standard Specifications for Seamless Admiralty Condenser Tubes and Ferrule Stock (B 44 – 24);
Standard Specifications for Free-Cutting Brass Rod for Use in Screw Machines (B 16 – 18);
Standard Specifications for Naval Brass Rods for Structural Purposes (B 21 – 27).

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, pp. 1118-1120 (1928); also 1928 Book of A.S.T.M. Tentative Standards, pp. 850-852.

Tentative Standards Continued as Tentative:

Since the following specifications have been tentative for only a year (or two in the case of Specifications B 68 – 27 T) the committee deems it advisable that they be continued as tentative for at least another year in order to be sure that no criticisms or suggestions would cause them to need revision immediately upon their advancement to standard.

Tentative Specifications for Brass Ingot Metal, Graded and Ungraded, for Sand Castings (B 30 – 28 T);

Tentative Specifications for Copper Tubing for Refrigerators (B 68 – 27 T);

Tentative Specifications for Sand Castings of the Alloy: Copper 80 per cent; Tin 10 per cent; Lead 10 per cent (B 74 – 28 T);

Tentative Specifications for Seamless Copper Tubes (B 75 – 28 T).

The committee also recommends that the tentative revision of the Standard Specifications for Bronze Bearing Metal in Ingot Form (B 31 – 21), proposed in 1928, be continued as tentative.

There have been no specific demands for specifications for sand cast alloys other than those now covered by the Society's specifications.

The committee is arranging through the Executive Committee of the Society for suitable cooperation with the American Welding Society in the formulation of specifications for manganese bronze welding rod acceptable to the large users of such material and also possibly specifications for other grades of welding rod.

The recommendations appearing in this report have been submitted to letter ballot of the committee with the following results:

Items	Affirmative	Negative	Not Voting
I. ADVANCEMENT TO STANDARD OF TENTATIVE REVISIONS OF STANDARDS			
1. Revisions of Standard Specifications for Cartridge Brass (B 19 – 19)	18	0	8
2. Revisions of Standard Specifications for Cartridge Brass Disks (B 20 – 19)	17	0	8
3. Revisions of Standard Specifications for Seamless Admiralty Condenser Tubes and Ferrule Stock (B 44 – 24)	19	0	7
4. Revisions of Standard Specifications for Free-Cutting Brass Rod for Use in Screw Machines (B 16 – 18)	18	1	7
5. Revisions of Standard Specifications for Naval Brass Rods for Structural Purposes (B 21 – 27)	20	0	6

This report has been submitted to letter ballot of the committee, which consists of 42 members; 26 members returned their ballots, of whom 25 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

C. H. MATHEWSON,
Chairman.

N. L. MOCHEL,
Secretary.

EDITORIAL NOTE

The tentative revisions of the Standard Specifications for Cartridge Brass; for Cartridge Brass Disks; for Seamless Admiralty Condenser Tubes and Ferrule Stock; for Free-Cutting Brass Rod for Use in Screw Machines; and for Naval Brass Rods for Structural Purposes were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929. The standard specifications in their revised form appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 98, 101, 108, 105 and 102, respectively.

REPORT OF COMMITTEE B-7
ON
LIGHT METALS AND ALLOYS, CAST AND WROUGHT

Committee B-7 is the outgrowth of a reorganization of the A.S.T.M. Committee B-2 on Non-Ferrous Metals and Alloys. It replaces Sub-Committee VIII on Light Metals and Alloys of Committee B-2 and has inherited the unfinished work of this group. The personnel of Committee B-7 is substantially the same as that of former Sub-Committee VIII.

The organization meeting was held in East Pittsburgh, Pa., December 14, 1928. The second meeting was held on March 21, 1929, during the Spring Group Committee Meetings in Chicago. Five sub-committees have been formed as follows:

Sub-Committee I on Aluminum and Aluminum Alloy Ingots
Sub-Committee II on Aluminum and Aluminum Alloy Sheet
Sub-Committee III on Aluminum and Aluminum Alloys, Wrought Shapes Other than Sheet
Sub-Committee IV on Aluminum-Base Casting Alloys
Sub-Committee V on Magnesium and Magnesium-Base Alloys, Cast and Wrought

SUB-COMMITTEE ACTIVITIES

Sub-Committee I on Aluminum and Aluminum Alloy Ingots (E. H. Dix, Jr., chairman).—This sub-committee recommends that the Tentative Specifications for Aluminum Ingots for Remelting (B 24 – 26 T)[1] be advanced to standard with the following revisions:

Section 1.—Change Grade 98.0 in the table to read as follows by the addition of the italicized figures and the omission of those in brackets:

[98.0] *98.5*..........................[98.0] *98.5* (minimum)

Section 2.—Change the first sentence to read as follows by the addition of the italicized words:

2. The presence in any of the above grades of *more than a trace of* manganese, magnesium, zinc, calcium or similar metals commonly used in the light alloys, is not admissible and such ingot cannot be classed as virgin aluminum under these specifications.

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[1] *Proceedings,* Am. Soc. Testing Mats., Vol. 26, Part I, p. 713 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 133.

Section 8.—In the last sentence of this section change the phrase "the 98.0 grade" to read "the 98.5 grade."

Future work of this sub-committee includes the drafting of specifications for aluminum-copper and aluminum-silicon hardeners.

Sub-Committee II on Aluminum and Aluminum Alloy Sheet (R. J. Anderson, chairman).—This sub-committee recommends that the Tentative Specifications for Aluminum Sheet (B 25 – 26 T)[1] be advanced to standard with the following revision:

Add a new Section 1 on scope to read as follows, renumbering the present sections accordingly.

> 1. *Scope.*—These specifications cover flat aluminum sheet. Strip or coil sheet may show somewhat lower elongations than those specified but is required to conform to the requirements of the same bend test as the flat sheet.

It is the intention of this sub-committee to prepare specifications for an aluminum alloy containing $1\frac{1}{4}$ per cent of manganese, corresponding to Alloy 3*S* of the Aluminum Co. of America, and specifications for duralumin sheet.

Sub-Committee IV on Aluminum-Base Casting Alloys (V. Skillman, chairman).—The rapid development of the aluminum casting industry has made obsolete the Tentative Specifications for Aluminum Base Alloy Sand Castings (B 26 – 26 T) and for Aluminum-Base Sand-Casting Alloys in Ingot Form (B 58 – 26 T). Extensive revisions of these specifications are under consideration and the sub-committee accordingly recommends that the specifications be temporarily continued as tentative.

Sub-Committee V on Magnesium and Magnesium-Base Alloys, Cast and Wrought (John A. Gann, Chairman).—This sub-committee is being organized to take care of the work on magnesium. Plans are now under way for drafting specifications on magnesium-base casting alloys.

The recommendations appearing in this report have been submitted to letter ballot of the committee with the following results:

Items	Affirmative	Negative	Not Voting
I. ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
1. Tentative Specifications for Aluminum Ingots for Remelting (B 24 – 26 T)	15	0	8
2. Tentative Specifications for Aluminum Sheet (B 25 – 26T)	16	0	7

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 715 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 135.

This report has been submitted to letter ballot of the committee, which consists of 25 members; 23 members returned their ballots, of whom 15 have voted affirmatively.

Respectfully submitted on behalf of the committee,

J. B. JOHNSON,
Chairman.

JOHN A. GANN,
Secretary.

EDITORIAL NOTE

The Tentative Specifications for Aluminum Ingots for Remelting, and for Aluminum Sheet, as revised, were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 85 and 87, respectively.

REPORT OF COMMITTEE C-1
ON
CEMENT

The activities of Committee C-1 have been directed during the past year towards two objectives. The first of these was towards the development and putting into execution of the idea of establishing a laboratory where the equipment and methods used in the testing of cement might be calibrated and standardized and also in which instructions in their maintenance and use could be given. The second objective was directed towards further studies of the present methods used in testing cement as compared with the method suggested at the last annual meeting by Brickett.[1] Both of these methods were to be considered from the viewpoint of concordance of results obtained by the different laboratories and the reliability of both methods in predicting strength which the cement under test might develop in a concrete. These activities of the committee were not new but were commented upon in its last annual report, but they are two matters which the entire personnel of the committee seems to feel are of primary importance to the satisfactory purchase of cement under specification.

Through the efforts of one of its members, Mr. F. W. Kelley, there was secured the promise of a fund of $12,500 which would be placed in the hands of the Society for expenditure under the direction of the committee, for the maintenance of the suggested Reference Laboratory at the Bureau of Standards. It was felt, however, that about twice this amount would be needed in order to have the laboratory render the required service in a manner that was believed to be adequate. A special committee was therefore appointed which after further consideration of the matter delegated the duty to three of its members (Messrs. F. W. Kelley, Cloyd M. Chapman, and the late Richard L. Humphrey) of bringing the situation to the attention of the Director of the Bureau of Standards, the Secretary of the Department of Commerce and the Director of the Bureau of the Budget, and requesting the insertion of an item for a similar amount in one of the deficiency bills to be placed before Congress, to supplement the funds promised through the Society.

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[1] E. M. Brickett, "A Plastic Mortar Compression Test for Cement," *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part II, p. 432 (1928).

As a result of the activities of the three members, who personally visited the three officials mentioned above, the item was placed in one of the deficiency appropriation bills, and passed the last Congress during the last week of its session. Since then the funds promised to the Society through Mr. Kelley's efforts have been deposited with the Society, the personnel required for the operation of the laboratory employed, and the equipment and the other necessary details so advanced that by the first of July it is hoped that the laboratory will be able to render its contemplated services.

For the further information of the Society there is appended hereto the report of the special sub-committee on the reference laboratory to the committee as a whole, covering the arrangements under which the laboratory will function, the scope of its work, and in a general way how its activities will be carried out. In the preparation of this the committee had the personal assistance of Mr. G. W. Thompson, the President of the Society. To assist further in carrying on the work, Committee C-1 has appointed a permanent committee composed of Messrs. Kelley, Ashton, Chapman, Goldbeck, Gonnerman, Jackson and Mattimore, as well as inviting the Executive Committee of the Society to appoint a member to act in a liaison capacity in assisting in the direction of the activities of the laboratory.

TABLE I.—SUMMARY OF RESULTS OF PRELIMINARY SERIES OF MORTAR STRENGTH TESTS.

		Compressive Strength, lb. per sq. in.						
		Laboratory No. 1	Laboratory No. 2	Laboratory No. 3	Laboratory No. 4	Laboratory No. 5	Laboratory No. 6	Laboratory No. 7
Gravel A	**Average**	2530	2570	2760	1905	2330	2120	2830
	Maximum	2740	2620	2910	2100	2520	2200	2880
	Minimum	2310	2500	2570	1810	2165	1990	2790
	Spread[a]	430	120	340	290	355	210	90
Local Gravel	**Average**	2530	2300	2340	1605	2045	2180	2290
	Maximum	2740	2380	2840	1810	2205	2420	2500
	Minimum	2310	2240	2120	1435	1875	1840	2110
	Spread[a]	430	140	720	375	330	380	390
Local Sand	**Average**	2470	2190	2610	2460	2735	2550	2570
	Maximum	2760	2410	3060	2800	3385	2720	2740
	Minimum	2130	2020	2350	2125	2180	2410	2380
	Spread[a]	630	390	710	675	1205	310	360
Ottawa Pit Run	Average	2080	2070	2170	2155	2160	2370	2270
	Maximum	2330	2270	2380	2575	2640	2485	2500
	Minimum	1950	1860	1780	1915	1405	2130	2040
	Spread[a]	380	410	600	660	1235	355	460

[a] Spread between maximum and minimum.

The data presented in the paper by Brickett seemed so suggestive and promising to Sub-Committee VII on Strength that after some discussion it adopted in October a program for a series of tests which it was felt would give the method a rather severe preliminary trying out. This program is presented in Appendix II to this report. It was also decided that two series of tests were to be carried out. In the first series, eight laboratories were to make the tests at one age only and with one cement, but all were to use in addition to their local sand and local aggregates an aggregate prepared at one of the cooperating laboratories and pit run sand from the same source which produces standard Ottawa sand. Table I gives a very brief summary of some of the data obtained in this preliminary series.

Without going into any extended discussion of these, or of the other data obtained, it was noted that the seven laboratories reporting obtained unusual concordance in the test specimens made with the Ottawa sand; that the strength of both this sand and the local sands approached the strength of the concrete sufficiently closely to justify special interest in the matter; but that the laboratories were not in satisfactory concordance in the strengths of the concrete made of the same aggregates as they should have been.[1]

Since then the second portion of the program of tests has been completed but the data have not been sufficiently studied by the sub-committee to permit of placing any discussion before the Society at the time of preparing this report. However, it is proposed by the sub-committee to place a report before the committee as a whole at its meeting during the annual meeting of the Society.

The Sub-Committee on High Early Strength Cements presented to the committee in October a definition of high early strength cement. At the April meeting this was a matter of much discussion. It was, however, adopted and referred to the various sub-committees for study in their work. This definition is as follows:

> High early strength hydraulic cement shall yield in forty-eight hours strength values not under the designed strengths required at twenty-eight days of concrete made with the same proportions, using standard portland cement, when fabricated and tested by standard laboratory methods of the A.S.T.M.

It will be noted from the report of the special committee on the reference laboratory that one of the functions of the latter is the calibration of equipment used in testing cement. This of necessity carries with it the demand for tolerances for the performance of such equipment. As a consequence, the Sub-Committee on Apparatus has been directed by the committee to submit at the meeting in June such tolerances as it feels are needed. This it is hoped can be approved and submitted during the meeting to the Society for adoption as tentative. Since the reference laboratory cannot proceed with the calibration of equipment which is fundamental to all its activities without such tolerances, it would seem to be justifiable to make use of one of the emergency procedures which the Society's regulations provide, for this present unusual and not fully anticipatable condition.

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[1] The low strengths obtained by one of the laboratories are due to an unfortunate and unforeseen low temperature in the storage room where the concrete specimens were maintained.

It is necessary again to ask that the Tentative Specifications and Tests for Compressive Strength of Portland-Cement Mortars (C 9 - 16 T) be continued as tentative. This has been a matter of much discussion during the year, but in view of the lack of more satisfactory values and methods for compression tests it is believed that the present tentative ones should be continued, notwithstanding their long history as tentative standards.

The committee had two very well-attended meetings during the year. The discussion which took place indicated a marked interest on the part of the membership in the work of the committee.

This report has been submitted to letter ballot of the committee, which consists of 71 members; 65 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

P. H. BATES,
Chairman.

F. H. JACKSON,
Secretary.

APPENDIX I

REPORT OF SPECIAL COMMITTEE ON REFERENCE LABORATORY

The 70th Congress appropriated $12,500 for the U. S. Bureau of Standards to carry out the Reference Laboratory plan. The Portland Cement Association had previously appropriated a similar amount to match a Government appropriation.

The Executive Committee of the Society approved of the plan as approved by Committee C-1 at its meeting of October 19, 1928, with certain limitations or understandings.

Accordingly a meeting was held in Washington on March 25, 1929, to formulate detailed plans for carrying on the work. At this meeting Mr. G. K. Burgess, Director of the Bureau of Standards, Mr. G. W. Thompson, President of the Society, and Mr. P. H. Bates, Chairman of Committee C-1, met with members of the Special Committee on Reference Laboratory.

The following was outlined as the work to be done and methods to be followed by the laboratory. Other details must be worked out as the plan develops.

> Establish at the U. S. Bureau of Standards at Washington, a fellowship to be known as "Cement Reference Laboratory for Standard Cement Testing."
>
> Under this fellowship, establish a laboratory with apparatus and personnel capable of making tests of portland cement in strict conformance with the standard specifications and tests of the A.S.T.M. The work at first will be confined to physical testing.
>
> This laboratory staff to be prepared to instruct on established methods of making tests, and proper methods for maintaining testing equipment, also to calibrate testing equipment submitted by purchasers or by manufacturers of such equipment.
>
> This laboratory staff to make at the request of the directing head of a cement testing laboratory, report upon the adequacy and accuracy of its apparatus to make cement tests to conform with the standard specifications. Suitable certificates covering the apparatus only will be issued to laboratories entitled to them.
>
> To make upon request, tests of cement for the purpose of enabling a laboratory to check its results with those of the Reference Laboratory. It will be desirable to limit such check tests to cases where the apparatus in the outside laboratory has been inspected and certified as correct.

In addition to its general educational work in establishing a wider understanding and better use of standard methods in cement testing, the laboratory will, as time and means permit, study the effect of variations in time of performing the different operations involved in standard cement testing, reporting the results to Committee C-1, together with studies of other methods, apparatus and conditions which may be useful to Committee C-1 in its efforts to improve the concordance of results in cement testing.

It is proposed to locate the laboratory in the Industrial Building of the Bureau of Standards at Washington, with every facility for maintaining standard conditions, where these are specified, and ideal conditions otherwise. The laboratory will be equipped so far as possible with all satisfactory testing apparatus now available on the market. Mr. J. R. Dwyer, who has had 12 years' experience in cement testing at the Bureau of Standards, will be in charge of the laboratory.

The instruction to be given by the laboratory staff will be of two classifications: (1) in Washington, and (2) in the field.

1. In Washington detailed instruction will be given in the making of test specimens and in the methods of testing. Instruction will also be given in the maintenance of testing equipment and in checking the calibration of equipment.
2. In the field the instruction will consist principally of criticism of methods and conditions noted in each laboratory visited, and suggestions will be given for improving them. At the same time testing equipment in the laboratory visited will be calibrated where possible and instruction given in proper maintenance of equipment.

The service will be available upon application only and will be rendered as nearly as possible in the order in which applications are received. Instruction in Washington may be expected to occupy two or more weeks, depending upon the aptitude of the men sent for training.

The schedule of the laboratory representatives giving instruction in the field must obviously be arranged by routes to avoid unnecessary traveling. A couple of days only can be allotted to each laboratory on each visit.

Application for service should be made to the Cement Reference Laboratory, care of Bureau of Standards, Washington, D. C.

It is probable that the laboratory will not be ready to begin service before July 1, 1929.

It is the intention of the laboratory to calibrate tension testing machines, scales, balances, needles, briquet molds and sieves. Tolerances for sieves have already been fixed by Committee C-1. Tolerances must be fixed for all apparatus calibrated, and we expect to present at the next meeting of Committee C-1 some proposed tolerances for the apparatus, except sieves. We suggest that these recommendations be referred to the Sub-Committee on Apparatus for report to Committee C-1 as soon as possible, but not later than the Atlantic City meeting in the week of June 24, 1929.

The criticism and suggestions of the laboratory representatives are to cover the matters in the Manual of Cement Testing[1] issued by Committee C-1, including conditions of humidity and temperature and observed individual application in each laboratory of the prescribed methods.

Under instruction in maintenance it is proposed to point out the importance of matters in the manual like rate of flow of shot, cleanliness of needles, molds, sieves and general care of apparatus.

It is proposed to issue certificates only from Reference Laboratory headquarters in Washington. A certificate will be issued for each machine. The time or life of the certificate will depend upon the appropriate time for each machine. These times are to be determined by later study. In no case shall the Reference Laboratory issue a written rejection or refusal to certify any particular kind of apparatus.

Certificates will be issued to manufacturers of apparatus of the classifications for which we propose to issue certificates so that users may purchase calibrated and certified apparatus. Such apparatus as well as apparatus submitted by users will be tested when sent to Washington and a nominal charge made for the service. Fees charged shall be in accordance with the regulations of the Bureau of Standards. The fee charged for such services must be transferred to the Treasury Department for deposit, and will not be available for expenditure. There will be no charges for the services rendered in the field to users.

Check tests between the Reference Laboratory and other laboratories will probably have to be confined to tests on periodic samples of cement sent out by the Reference Laboratory to those who have expressed a desire to make such comparative tests.

The funds contributed by the industry to the work will be paid at intervals into the treasury of the Society. Vouchers against these funds will be approved by the Chairman of Committee C-1 and by such others as may be later designated, and will be paid directly to the parties in whose favor they are drawn.

Monthly reports of the work of the Reference Laboratory will be made through the Director of the Bureau of Standards to the Society. These reports will cover the amount and kind of work done and the expenditures involved. A copy of this report will be furnished to Committee C-1 by the Society.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part I, p. 161 (1925).

The staff will consist of a chief and four assistants. Of these, two and sometimes three assistants will be in the field most of the time. The Bureau of Standards is now assembling the personnel and apparatus and will use every effort to be ready to give service by July 1—before which time it will be essential for Committee C-1 to fix the tolerances above referred to, in order that the important work of calibration may proceed.

A special committee of Committee C-1 should be provided to cooperate with the Bureau of Standards in carrying on the Reference Laboratory, to receive reports, and generally to act as a contact between the Reference Laboratory and Committee C-1. The Executive Committee of the A.S.T.M. should be invited to appoint a representative to sit with this committee.

Respectfully submitted on behalf of the Special Committee on Reference Laboratory,

F. W. KELLEY,
Chairman.

APPENDIX II

TENTATIVE OUTLINE OF TEST PROCEDURE FOR COOPERATIVE PLASTIC MORTAR TESTS

General Remarks

The participants in these tests shall understand that the tests are focused on an evaluation of the plastic mortar compression test with two main objects in view:

(*a*) To find out whether a given laboratory, using its local aggregates of known good quality, can obtain a reasonable agreement between concrete strengths and plastic mortar strengths, following the procedure set forth herein.

(*b*) To find out whether a definitely specified plastic mortar test of different cements with Ottawa run-of-mine sand will give reasonably concordant results in different laboratories.

Group I. Concrete Tests

A. Preliminary Tests for Proportions

1. *Preparation of Composite Sample.*—Of the eight cements to be furnished the participating laboratories, six are selected to represent fairly well the range of normal portland cements. From these six cements a 60-lb. composite sample shall be made up by taking 10 lb. of each, and mixing them thoroughly by rolling on a tarpaulin.

2. *Trial Batches.*—Using this composite cement, local fine and coarse aggregate in the proportion of 2:3, and sufficient water to give a water-cement ratio of 0.8 without allowance for absorption, make up a trial batch of concrete sufficient for one 6 by 12-in. cylinder. The aim is to add just sufficient aggregate to obtain a consistency equivalent to a slump of 5 in., maintaining the ratio of 0.67 between fine and coarse aggregate.

Note.—It is expected that all laboratories will use the flow table for measurement of consistency throughout these tests, but the fact that different practices are followed in the use of this device makes it necessary to refer to a "consistency equivalent to a slump of 5 in." Sufficient preliminary tests will have to be made in each laboratory to obtain the relation between flow and slump, so that a definite value of flow can be substituted for the 5-in. slump. These tests should be made and the relation established before the work of this investigation is started, using local materials similar to those which will be used in the investigation. These tests are not to be made, however, with the cements furnished by the sub-committee, as the latter must be conserved to cover the possible loss in trial batches and discarded batches.

3. *Suggested Procedure.*—It is suggested that a 1:2:3 mix be tried first; then, if the specified flow is not attained, the aggregate proportion be adjusted accordingly and the trials repeated until a mix is obtained having a slump

within the limits of 5 in. ± 1 in., of the following proportion of cement, fine aggregate and coarse aggregate:

$$1:x:1.5x$$

where x is the volume of fine aggregate, dry and rodded, and $1.5x$ is the volume of coarse aggregate, dry and rodded.

4. *Proportions by Weight.*—From the weights per unit volume of fine and coarse aggregates, the proportions determined shall be converted to proportions by weight, and these weight proportions shall be adhered to in making up all batches of concrete in which the six normal portland cements are used.

5. *Separate Determinations for Special Cements.*—In the case of the high early strength cement and the masonry cement, trial batches shall be made, using a water-cement ratio of 0.8 as before, and the proportions of fine and coarse aggregate as determined by trial with the composite of the normal cements. If the flows obtained with either of these mixtures vary more than ±1 in. from the specified flow, the proportion of total aggregate shall be changed (maintaining, however, the ratio of 0.67 between fine and coarse), and shall be determined by trial for each, such that the flow shall fall within the above-mentioned limits. The weight proportions for each shall then be computed, and they shall be adhered to in making up all batches with these cements.

B. *Tests of Group I*

6. *Consistency Fixed, Water-Cement Ratio Variable.*—The proportions of cement and aggregate to be used in each mixture shall have been determined from the preliminary tests. These shall be adhered to throughout the series, but it can hardly be expected that the six normal cements will yield exactly the specified flow if a constant water-cement ratio is used throughout. For the purpose of these tests it is believed desirable to maintain a constant consistency throughout the series and to allow the water-cement ratio to vary slightly as may be necessary to obtain this consistency.

7. *Procedure in Mixing and Testing for Consistency.*—Each batch of concrete shall be mixed dry in a pan, using the predetermined quantities of cement and aggregate sufficient for making a 6 by 12-in. cylinder. Sufficient water shall first be added to give a water-cement ratio in the mixture of about 0.75. In most cases this will be found insufficient for the desired consistency, and enough additional water shall be added until, in the judgment of the operator, the desired consistency is obtained. If the consistency as measured is considerably at variance with the consistency desired, the batch shall be discarded and the trial repeated. It may be suggested that a maximum variation of 1 in. from the desired flow will be satisfactory. Within these limits, then, flow will be recorded, and also the exact amount of water used, which will later be expressed as water-cement ratio, for each batch.

8. *Program of Mixing and Testing.*—As each batch of concrete is sufficient for only one 6 by 12-in. cylinder, the mixing program is quite flexible. To conform with the mortar program, however, it will be desirable to make up four concrete cylinders with a given cement on a given day, one of these to be tested at each of the ages, 2, 4, 7 and 28 days. This same program with the given cement will be repeated on three different days, so that the four companion specimens at any test age will have been taken from batches mixed on four different days.

NOTE.—The following general program of procedure is recommended: With any given cement, it is highly desirable that the four groups of tests be carried out on the same day. Thus one laboratory, having completed the preliminary tests, will begin its program, let us say, with Cement A, and on the first day will make up the four concrete cylinders of Group I, the four local sand mortar cubes of Group II, the four Ottawa run-of-mine sand mortar cubes of Group III, and the four standard mortar briquets of Group IV. All of the laboratories will probably have sufficient equipment to carry out at the same time the same program with Cement B, perhaps also with Cements C and D. Whatever the facilities, it is recommended that all the cements be put through the "first round" in succession, whether the time required be 1 day, 2 days or 4 days. Thereafter the program will be repeated in the same manner for the second and subsequent rounds. It is important, however, that the second and subsequent rounds be made independently of the earlier results, and that the operators be not guided by the data of preceding rounds.

GROUP II. LOCAL SAND MORTAR TESTS

A. Preliminary Tests for Proportions

9. *Trial Batches.*—Using the normal portland cements prepared for the preliminary tests, that portion of the local sand which has been screened through a No. 8 sieve, and sufficient water to give a water-cement ratio of 0.8 without allowance for absorption, make up a trial batch of plastic mortar sufficient for making four 2-in. cubes. The aim is to add sufficient sand to obtain a consistency equivalent to a flow of 45 ± 5 on the 10-in. flow table.

10. *Preparation of Sand and Determination of Quantity to be Used.*—In making this and subsequent trial batches the cement and a quantity of sand somewhat less than the required amount are to be mixed dry in a pan formed into a crater and then the measured quantity of water is to be added. The mortar is then mixed in the specified manner, and enough additional dry sand is added until the desired consistency is obtained. If this consistency is reached with a total quantity of sand between 2 and 3½ times that of the cement, the sand as prepared will be satisfactory and a quantity sufficient for the entire series of tests will be prepared. If, however, the ratio of sand to cement is greater than 3½, the sand is still too coarse, and a quantity must be prepared from that which passes a No. 12, or possibly even a No. 16 sieve. A few preliminary trials will indicate which sieve should be used in scalping the local sand—that which gives a mortar of the desired consistency of proportions between 1:2½ and 1:3, being the one which is considered most suitable.

11. *Separate Determinations for Special Cements.*—The maximum size and the proportions of sand having thus been determined for the composite cement, similar trials should be made using this sand with the high early strength cement and with the masonry cement. The quantities of sand will presumably be somewhat different with these cements to give the desired consistency, but once determined they will be adhered to throughout the tests of Group II.

B. Tests of Group II

12. *Proportions.*—The proportions of cement and prepared local sand to be used in each mixture will have been determined from the preliminary tests. These shall be adhered to throughout the series.

13. *Procedure in Mixing and Testing for Consistency.*—The procedure shall be as follows: Each batch of mortar shall first be mixed dry in a pan using the predetermined quantities of cement and sand sufficient for making four 2-in. cubes. The water to be added shall be such as to give the *same water-cement ratio as used in the corresponding concrete* without allowance for absorption. In each day's program the tests of Group I will necessarily precede those of Group II, in order that the quantities of water to be used in the individual mortar batches may be computed. For each batch of mortar, the flow or consistency shall be measured and recorded.

14. *Program of Mixing and Testing.*—Since tests of plastic mortar are to be made at the ages of 2, 4, 7 and 28 days, each batch of mortar shall be sufficient for making four 2-in. cubes. One cube of each batch shall be tested at each of the ages specified. Since four companion specimens are to be made for each age, and these are to be made on different days, four similar batches of mortar from any given cement must be mixed on four different days.

GROUP III. OTTAWA RUN-OF-MINE SAND MORTAR TESTS

15. *Procedure in Mixing and Testing for Consistency.*—Paralleling the tests of Group II, Ottawa run-of-mine sand mortars will be made using a water-cement ratio of 0.8, in batches sufficient for making four 2-in. cubes. The procedure shall be as follows: Mix dry in a pan the predetermined quantity of cement and about $2\frac{1}{2}$ parts of Ottawa run-of-mine sand. Add the predetermined quantity of water and mix in the specified manner. Enough additional run-of-mine sand shall then be added until, in the judgment of the operator, the desired consistency has been reached. The mortar shall then be tested for consistency on the 10-in. flow table, and shall have a flow within the limits 45 ± 5. If outside these limits, the batch shall be discarded, and the mix repeated until the desired consistency is obtained. When the mortar is of satisfactory consistency, it shall be made into cubes in the prescribed manner.

16. *Program of Mixing and Testing.*—The number of specimens of Ottawa sand mortar, and the program of mixing and testing are identical with those prescribed in Section 14 for the local sand mortars.

GROUP IV. STANDARD OTTAWA SAND MORTAR TENSION TESTS

17. *Program of Mixing and Testing.*—Group IV comprises a set of standard Ottawa sand mortar tension tests on each of the cements, made according to the Standard Specifications and Tests for Portland Cement (A.S.T.M. Designation: C 9), except that the number of specimens, and the program of mixing and testing parallel those of the plastic mortars given above (Sections 14 and 16). Thus four briquets are to be made from each batch, one of these to be broken at each of the following ages: 2, 4, 7 and 28 days. The four companion specimens for each age are to be obtained from different batches mixed on four different days.

OUTLINE OF COOPERATIVE TESTS OF CEMENT

Group	Mix	Aggregates	Nominal Water-Cement Ratio	Consistency	Specimen	Age at Test, days	Strength Tests	
							On Each Cement	On 8 Cements
				STRENGTH TESTS OF CONCRETE AND MORTAR				
				Concrete				
I	Mixes fixed by trial using composite sample of cement.	Local sand and local stone or gravel.	0.80[a]	Slump constant, 5 in. ± 1 in.	6 by 12-in. cylinder.	2, 4, 7, and 28.	16	128
				Mortar				
II	Mixes fixed by trial using composite sample of cement.	Local sand scalped to give about 1:2¾ mix by weight for 0.8 water-cement ratio.	Same as concrete for a given cement.	Flow measured on 10-in. flow table using 30 ⅛-in. drops.	2-in cube.	2, 4, 7, and 28.	16	128
III	Variable depending on water-cement ratio and consistency.	Run-of-mine Ottawa sand.	0.80	Flow 145 ± 5 measured on 10-in. flow table using 30 ⅛-in. drops.	2-in. cube.	2, 4, 7, and 28.	16	128
IV[b]	1:3	Standard Ottawa sand.	....	A.S.T.M. Normal Consistency.	Briquet.	2, 4, 7 and 28.	16	128
	Total for each laboratory.........		....	....	....	....	....	512

MISCELLANEOUS TESTS

Cement

Normal consistency.
Time of setting with Vicat and Gillmore needles.
Penetration tests with Vicat needle.
Fineness on No. 200 sieve.
Soundness over boiling water.
Volume change (by those laboratories equipped to make tests).

Aggregates

Sieve analysis.
Absorption after ½, 1, 2, 6 and 24 hr.
Unit weight (fine, coarse and mixed aggregate).
Specific gravity.

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[a] May vary slightly with different cements; quantity of water to be such as will give the required slump with the fixed mix.

[b] It is requested that laboratories which are in a position to do so, repeat the tests in this group on the seven portland cements using a uniform water content of 10.4 per cent by weight of dry materials.

OUTLINE OF PRELIMINARY TESTS

One batch to be made for each condition on 5 different days.

Group	Cement	Mix by Weight of Dry Materials	Aggregate	Nominal Water-Cement Ratio	Consistency	Specimen		Age at Test, days
						Kind	Number	
1	C-1	1:2.4:3.6 (Concrete).	Elgin sand and gravel.	0.80	Measure.	6 by 12-in. cylinder.	5	7
2	C-1	Mix fixed by trial (Concrete).	Local sand and gravel (or crushed stone).	0.80	Slump 5 in. ± 1 in.	6 by 12-in. cylinder.	5	7
3	C-1	Mix fixed by trial (Mortar).	Local sand.	0.80	Flow 145 ± 5, 30 drops on 10-in. table.	2-in. cube.	5	7
4	C-1	1:2.75 (Mortar).	Run-of-mine Ottawa sand.	0.80	30 drops on 10-in. table. Measure. Flow.	2-in. cube.	5	7

REPORT OF COMMITTEE C-3
ON
BRICK

Committee C-3 has held two general meetings during the past year. The committee is making several recommendations in reference to the standards and tentative standards under its jurisdiction, as indicated below:

Tentative Specifications for Paving Brick (*C 7 - 28 T*).[1]—A complete revision of Sections 1 to 15 of these specifications has been prepared by Sub-Committee IV on Paving Brick, and it is recommended that these revisions, as appended hereto,[2] be accepted for publication as tentative to replace Sections 1 to 15 of the present tentative specifications. It is also recommended that other sections of these specifications be revised, as follows:

Section 26 (*a*).—Replace the first two sentences of this paragraph, reading as follows:

> The sample, together with the abrasive charge shall be placed in the rattler and the rattler closed. The rattler shall be rotated at a uniform rate of not less than 29.5 nor more than 30.5 revolutions per minute, and 1800 revolutions shall constitute the test.

with the following sentence:

> The test shall consist of 1800 revolutions of the rattler at the rate of not less than 29.5 nor more than 30.5 revolutions per minute.

Section 28.—Omit this section, reading as follows:

> 28. The percentages of loss, as calculated in accordance with Section 27, shall be corrected by subtracting from it the differential obtained from the following table, which corresponds to the initial weight of the ten brick composing the test charge. The corrected result shall be reported as the corrected percentage of loss.

WEIGHT OF 10 BRICK BEFORE TEST, LB.	CORRECTION DIFFERENTIAL, PER CENT
95 or over	0
90 to 94 inclusive	1.0
85 to 89 "	1.5
80 to 84 "	2.5
75 to 79 "	3.0
70 to 74 "	3.5
65 to 69 "	4.0
60 to 64 "	5.0
59 or under	6.0

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 842 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 266.

[2] See p. 628.—ED.

In all cases where the initial weight of 10 brick in pounds and tenths of a pound lies between the upper limit of one grade and the lower limit of the next heavier grade, the brick shall be classified in the heavier grade when the fractional part of the weight is 0.5 lb. or more.

Section 29.—Omit the Note at the end of this section reading as follows:

NOTE.—For the convenience of those making use of the test, the accompanying blank form, which provides space for the necessary data, is furnished and its use is recommended.

Report Form.—Omit the report form entitled "Report of Standard Rattler Test of Paving Brick" appearing at the end of the specifications.

It is recommended that the Tentative Specifications C 7 – 28 T as thus revised be continued as tentative and that the Standard Specifications for Paving Brick (C 7 – 15),[1] of which the tentative specifications are in effect a complete revision, be withdrawn.

TABLE I.

Items	Affirmative	Negative	Not Voting
I. PROPOSED REVISION OF TENTATIVE STANDARD			
1. Tentative Specifications for Paving Brick (C 7 – 28 T)	32	1	5
II. ADVANCEMENT OF TENTATIVE STANDARD TO STANDARD			
2. Tentative Specifications for Building Brick (Made from Clay or Shale) (C 62 – 28 T)	34	1	3
III. WITHDRAWAL OF STANDARD			
3. Standard Specifications for Paving Brick (C 7 – 15)	34	0	4

Tentative Specifications for Building Brick (Made from Clay or Shale) (C 62 – 28 T).[2]—It is recommended that these specifications be advanced to standard without revision.

Tentative Specifications for Sand-Lime Building Brick (C 73 – 28 T).—It is recommended that these specifications be continued as tentative pending completion of a laboratory investigation of the strength properties of sand-lime brick.

Sub-Committee VI on Concrete Brick submitted a draft of new tentative specifications for concrete brick as the result of an informal conference with representatives of the Federal Specifications Board and the American Concrete Institute. However, owing to difference of opinion as to the proper basis for strength requirements, the subcommittee report was not accepted by Committee C-3. It is recommended that the Tentative Specifications for Concrete Building Brick (C 55 – 28 T) be continued as tentative.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 126.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 836 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 260.

The recommendations appearing in this report have been submitted to letter ballot of the committee with the results shown in Table I.

This report has been submitted to letter ballot of the committee, which consists of 40 members; 38 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee.

T. R. LAWSON,
Chairman.

J. W. MCBURNEY,
Secretary.

EDITORIAL NOTE

The proposed revision of the Tentative Specifications for Paving Brick was accepted. The tentative specifications in their revised form appear on page 628.

The withdrawal of the Standard Specifications for Paving Brick was approved.

The Tentative Specifications for Building Brick (Made from Clay or Shale) were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 127.

DISCUSSION

[Mr. H. T. Shelley, in presenting the Report of Committee C-3 on Brick recommended the advancement to standard of the Tentative Specifications for Building Brick (Made from Clay or Shale) (C 62 - 27 T).—Ed.]

Mr. T. C. Tayler.[1]—I am interested in this recommendation as a manufacturer of sand-lime brick. I think that there should be one specification for both sand-lime and clay brick. The tentative specifications for sand-lime and clay brick are different. The difference between them is just this—the specifications for clay brick include both the modulus of rupture test and a crushing test; the specifications for sand-lime brick include the modulus of rupture test and an absorption test. As a matter of fact, the absorption on the average sand-lime brick is less than on clay brick. The same applies to sand-lime brick and to clay brick—that absorption is probably not very much of a factor in determining the weathering properties of brick.

So far as the clay brick specifications are concerned, I think that the crushing test as well as a modulus of rupture test is unnecessary. A modulus of rupture test would tell practically everything that a crushing test would tell. Modulus of rupture is a combination of a crushing test and a tension test. A brick that is weak either in crushing or in tension would fail with a lower modulus of rupture than one which had both factors high, either one being low the modulus of rupture test brings it out. So I do not see any necessity for having a crushing test. It will cause less brick to be tested, less development in the field of brick by having both requirements and there will be less use of the specifications by the architects and contractors. I think a specification which is reduced to the least possible requirement is the best. I think if a modulus of rupture test were the only requirement for both clay and sand-lime brick it would be better. I think the sand-lime brick specifications can be changed to eliminate the absorption requirement. It is only in very few cases that absorption should determine the quality of the brick, and those few cases I think could be handled separately. I would be willing to see it taken out of the sand-lime brick specifications, and I think at the same time that the crushing test ought to be taken out of the clay brick specifications. I would like to see the modulus of rupture the only factor for determining the quality of both the sand-lime brick and the clay brick.

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[1] **President and General** Manager, Sand Lime Products Co., Detroit, Mich.

I would move that the requirement for crushing strength be eliminated from the Tentative Specifications for Building Brick (Made from Clay or Shale) (C 62 – 27 T) that are now being recommended for advancement to standard.

MR. J. W. MCBURNEY[1] (*Secretary, Committee C-3*).—Might I have the privilege of answering Mr. Tayler briefly on just two points? The first is that these tentative specifications have now been on the books of the Society for two years. They were originally written by a meeting of the committee as a whole in which both the representatives from the sand-lime interests as well as the clay and the other interests participated.

Last year I reported to this Society[2] the results of a study of the compressive strength of masonry of some 168 walls 6 ft. long by 9 ft. high and 8 in. and 12 in. in thickness. That included the work that had been previously done at the Bureau of Standards on sand-lime brick walls. We found that the flat compressive strength of the brick units was very much better related to the crushing strength of the masonry than was the modulus of rupture.

Now I believe it is true that sand-lime brick has a much more uniform ratio of modulus of rupture to flat compressive strength than clay building brick, but clay building brick does not keep that ratio constant at all. It depends very largely on the manner in which the brick has been formed. To illustrate, I have in mind an end-cut brick which has a modulus of rupture of 1350 lb. per sq. in. which would put it in the "Super A" Grade. The flat compressive strength is low medium, 3300 lb. per sq. in. On the other hand, a side-cut brick may have an extremely low modulus of rupture, down to 600 lb. per sq. in., and be up to 6000 lb. per sq. in. in its compressive strength; and the work we have done so far at the Bureau of Standards indicates that when you build masonry of bricks varying in modulus of rupture and compressive strength, like the two I cited, the strength of the masonry follows the compressive strength and not the modulus of rupture.

I am inclined to agree with Mr. Tayler that it would be very desirable to have in the specifications a test which is more easily applied possibly in the field than is the compressive strength test. However, the present Tentative Specifications for Clay Brick for which we are asking the advancement to standard, have both the modulus of rupture and the compressive strength tests, also the committee explained two years ago that the water absorption is not included because it is not at all sure as to what the water absorption of a clay or shale building brick means. I am dealing with that in a paper presented at this annual meeting.[1]

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[1] Research Associate of the Common Brick Manufacturers Assn. of America at the U. S. Bureau of Standards, Washington, D. C.

[2] J. W. McBurney, "The Effect of Strength of Brick on Compressive Strength of Brick Masonry," *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part II, p. 605 (1928).

[The motion by Mr. Tayler to amend the specifications failed of a second and the motion to approve the advancement to standard of the specifications was carried.—ED.]

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[1] J. W. McBurney, "The Water Absorption and Penetrability of Brick," *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. (1929).

REPORT OF COMMITTEE C-4
ON
CLAY AND CEMENT-CONCRETE PIPE

The committee has held two meetings during the year.

At the meeting held November 14, 1928, the committee decided to reorganize with 31 members, to consist of 14 producers and 17 consumers and general interests, and that there should be two sub-committees, one on clay pipe and one on cement-concrete pipe, each to consist of 14 members, of whom 7 should be consumers or general interests and 7 producers. The three officers of the committee are to serve as *ex-officio* members on each sub-committee, but without vote. An advisory committee of 7 members was also provided, to consist of the three officers, the chairmen of the two sub-committees, and a producer member from each sub-committee.

This reorganization was put into effect at the meeting held April 3, 1929. Mr. James F. Sanborn of New York City was elected chairman of the Sub-Committee on Clay Pipe, and Mr. Asa E. Phillips of Washington, D. C., chairman of the Sub-Committee on Cement-Concrete Pipe.

These sub-committees are now ready to proceed with their work.

At the November meeting, Mr. Andrew J. Provost, Jr., resigned from the chairmanship of the committee, much to the sorrow of all its members. To fill the vacancy, the vice-chairman was promoted to the chairmanship, and Mr. Anson Marston was elected vice-chairman. Mr. E. S. Rankin was continued as secretary.

No changes in standard or tentative specifications are presented at this time, and it is desired that all tentative specifications remain tentative one year more. The committee is now engaged in a complete restudy of all specifications.

This report has been submitted to letter ballot of the committee, which consists of 28 members, 22 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

GEORGE T. HAMMOND,
Chairman.

ANSON MARSTON,
Vice-Chairman.

E. S. RANKIN,
Secretary.

REPORT OF COMMITTEE C-5

ON

FIRE TESTS OF MATERIALS AND CONSTRUCTION

The active work before Committee C-5 is the development of standard methods of conducting fire tests of lumber, applicable both to treated lumber and to lumber in its natural state. A sub-committee of Committee C-5 was appointed in December, 1927, to which this work was assigned, and the sub-committee has held meetings in June, 1928, and March, 1929.

Recognizing at the first of these meetings that satisfactory equipment and test methods could not be devised without extended experimental research, the sub-committee asked for and has been very generously accorded the cooperation of the Forest Products Laboratory at Madison, Wis. Committee C-5 expresses appreciation of the financial support extended by the National Lumber Manufacturers' Association for the conduct of this research work. Since the meeting in June, 1928, testing equipment has been devised, and the equipment has been used for extensive experiments on specimens of various kinds; and at its March, 1929, meeting the sub-committee had opportunity to examine the apparatus and witness it in operation, being favorably impressed with the demonstration.

Additional experimental work is under way with a view to determining whether other and supplementary forms of test are needed to yield the information judged to be necessary from the viewpoint of the user. The committee, therefore, will not report definite test requirements until the current research work has progressed somewhat further.

Committee C-5 has responsibility for only one existing tentative standard, the Tentative Specifications for Fire Tests of Building Construction and Materials (C 19 – 26 T). The sectional committee functioning under the American Standards Association, which developed these specifications, has not met during the past year for review of its past work. Committee C-5 believes that some further experience should be gained in the practical application of these Tentative Specifications to current problems before formal consideration is given to revisions or extensions. Committee C-5, therefore, recommends that the specifications be continued as tentative without revision.

This report has been submitted to letter ballot of the committee, which consists of 15 members; 15 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

Rudolph P. Miller,
Chairman.

Fitzhugh Taylor,
Secretary.

REPORT OF COMMITTEE C-7

ON

LIME

Committee C-7 has held three meetings during the past year. The first was held in conjunction with the annual meeting of the Society in June, 1928, at Atlantic City, the second in November, 1928, at Washington, D. C., and the third in connection with the group meeting at Chicago, Ill., during March, 1929.

As a result of deliberations during these meetings, Committee C-7 formally approved by letter ballot a resolution to the effect that the American Institute of Architects and the Society act as joint sponsors in requesting the American Standards Association to promote a sectional committee to draw up a set or sets of plastering specifications which would be national in their field of application. Such a sectional committee would be composed of representatives of all interested groups such as producers, consumers, producers of materials to which plasters are applied, those responsible for the execution of the work, and groups representing financial institutions, and would function under the A.S.A. procedure.

This request was subsequently placed before the American Standards Association and was approved in March of this year. In view of the fact that this project will be under way within a short time, Committee C-7 has submitted definite suggestions to the Executive Committee of the Society for their consideration in the final appointment of the representative of Committee C-7 on the sectional committee.

Another important matter now before Committee C-7 is the general reorganization of Sub-Committee II on Structural Lime, with the view of initiating a study of new material to be presented on finishing lime.

The Tentative Methods of Chemical Analysis of Limestone, Quicklime and Hydrated Lime (C 25 – 27 T), having been tentative for two years without revision, are recommended to the Society for advancement to standard.

The recommendation appearing in this report has been submitted to letter ballot of the committee with the following result:

Item	Affirmative	Negative	Not Voting
TENTATIVE STANDARD ADVANCED TO STANDARD			
Tentative Methods of Chemical Analysis of Limestone, Quicklime and Hydrated Lime (C 25 - 27 T)	23	0	12

This report has been submitted to letter ballot of the committee, which consists of 35 members; 26 members returned their ballots, of whom 25 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

H. C. BERRY,
Chairman.

W. V. BRUMBAUGH,
Secretary.

EDITORIAL NOTE

The Tentative Methods of Chemical Analysis of Limestone, Quicklime and Hydrated Lime were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 133.

REPORT OF COMMITTEE C-8

ON

REFRACTORIES

Committee C-8 held two meetings during the year subsequent to the annual meeting of the Society at Atlantic City in June, 1928. The first meeting was held in New York City, in October, in conjunction with the fall meeting of the American Refractories Institute and the second in Chicago in February concurrently with the annual meeting of the American Ceramic Society.

The committee recommends a tentative revision of the heating rate of the Standard Method of Test for Softening Point of Fire-Clay Brick (C 24 – 28)[1] from cones 31 to 35. In order to make the desired heating rate of 150° C. per hour a uniformly smooth curve, the following changes are recommended:

Section 5. (*a*).—In the table of heating rates change the time intervals for cones 31 to 35 to read as follows by the addition of the italicized figures and the omission of those in brackets:

Time interval to cone 31	[8] *12*	minutes
“ “ “ “ 32	[4] *8*	“
“ “ “ “ 33	[8] *18*	“
“ “ “ “ 34	[18] *6*	“
“ “ “ “ 35	[6] *10*	“

This increases the average time interval between cones 20 to 35 from 8.8 to 10.8 minutes.

The committee approved for publication in an appendix to the Standard Specifications for Clay Fire Brick for Malleable Furnaces with Removable Bungs and for Annealing Ovens (C 63 – 28), as information only, the Simplified Practice Recommendation No. 79–28 for Malleable Foundry Refractories of the Department of Commerce. This simplified practice is given in Appendix I to this report in the form in which it will appear in the Standard Specifications C 63.

In view of contemplated changes in the method of conducting the spalling test, the committee recommends that the Tentative Method of Test for Resistance of Fire-Clay Brick to Thermal Spalling Action (C 38 – 27 T) be continued as tentative another year.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 89.

The Sub-Committee on Nomenclature still has under advisement the definitions for the terms "spalling" and for "pyrometric cone equivalent." These are accordingly being continued as tentative for another year. A definitions of the term "brick" was furnished Committee E-8 on Nomenclature and Definitions, as requested. The sub-committee is considering the nomenclature related to high-temperature cements and their usage.

Industrial Survey of High-Temperature Cements:

The questionnaire submitted to some 200 power plant men during the past year by the Sub-Committee on Industrial Survey to determine the service conditions surrounding the use of high-temperature cements and other jointing materials was replied to by 65 plants. The replies have been condensed and the sub-committee has drawn certain conclusions as follows:

Nomenclature.—Definitions covering "fire clay," "fire clay and grog," and "high temperature cements" should be devised for use in specifications covering these cements.

Refractoriness.—Of major importance are the shrinkage and vitrification at boiler operating temperatures. Refractoriness as determined from the P.C.E. value only, is not sufficient.

Tightness of Joints.—In general, it is indicated by replies to the questionnaires that a satisfactory cement aids in reducing spalling of the brick work by preventing heat penetration and falling out of pieces of brick when cracking takes place. It is also indicated that tight joints aid in reducing slag erosion.

Workability and Ability to Stay in Suspension.—These properties are indicated as being important since they affect the labor cost for construction work, as well as the uniformity in thickness of the joints.

Air Setting.—The property of air setting is indicated as being a desirable feature in the majority of answers received, even though ground fire clay is most frequently used. (Statement is frequently made that new furnaces with cold-setting cements can be heated up more rapidly than where fire clay alone is used and also that the former have less drying shrinkage.)

Ability to Carry Loads.—In all but two cases the plants reporting stated that they had never seen any indication of the laying material being squeezed out of the joints and it is concluded that the ability to carry loads is so unimportant that it need have no consideration in specifications. This is to be expected in view of the thin joints normally employed.

Research:

The Sub-Committee on Research has continued its work on the service spalling test and the reheating test.

Service Spalling Test.—The service spalling test will differ from the present water-dipping spalling test described in Tentative Method C 38 – 27 T, in that it will measure resistance to a variety of factors causing spalling, whereas the present tentative test measures only resistance to thermal action.

A new type of furnace has been completed and experimental work conducted to determine the best procedure to classify various types of brick. Particular attention has been given to simulating typical service conditions. As in the earlier work on the service spalling test, the panels of brick are heated in order to simulate the vitrification produced in service. Tests are being conducted to learn of the effect of vitrification produced by time, temperature and slag coatings on the brick. After the preliminary vitrification has been produced spalling tests have been conducted to learn of the effect of varying the temperature and the rate of cooling. It appears that the higher temperatures for spalling are more conducive to thermal spalling.

Various methods have been utilized to rapidly cool the surface of the panel such as using different types of air blasts and combinations of an air blast and a mist of moisture. Considerable difficulty has been experienced in arriving at a satisfactory means to measure the loss produced by spalling. In some earlier tests the samples were removed from the panels and the loss of weight determined as an index to the amount of spalling. Removing the brick from the panels, however, to measure the weight loss gives a value for the amount of spalling so large that results are not comparable with service conditions. In later tests, the brick were left in the panel and the loss determined by volume displacement measurements.

Reheating Test.—In the committee's report last year, it was pointed out that a study of the reheating test was in progress in which a number of typical refractories were being exposed to continuous heating in commercial kilns for 98 days. These data were compared with the regular reheat data on the same brick. No relation was found between the results of the two heat treatments. This work has been continued during the past year by conducting a variation of the long-time heat test in the laboratory. The samples used were taken from the same lot of brick used in the earlier study. In this latter work the temperature of the test furnace is raised at a uniform rate to 1400° C. in 60 hours. This temperature is then maintained for 5 hours as in the regular reheating test.

Further refinement consisted in cutting the brick lengthwise so as to form two soap brick and heating one of these in the regular reheating test and the second in the laboratory variation of the long-time test. The linear shrinkage in both tests was essentially the same, suggesting that the rate of heating is not responsible for the difference in results obtained in laboratory firing, plant firing, or in industrial furnaces. It was thought that the slow rate of heating would indicate one of the causes of secondary expansion, but apparently not.

A special, draw trial test on the same brands of brick is being conducted at the present time to learn of the changes which may take place at different periods over the long-time firing. The porosity and volume at temperature intervals of 50° C. are to be determined. The next phase of the study will then be to determine the effect of oxidizing and reducing atmospheres during testing and the temperatures at which the effects occur.

Abrasion at High Temperature.—Mr. J. B. Shaw of Pennsylvania State College has consented to carry on the work which Mr. Brady of the United Gas Improvement Co. laboratories started on abrasion at high temperature of fire-clay refractories. The abrasion of silica refractories has been studied by Mr. S. S. Cole in the Koppers Co. laboratories and a test has been suggested. The data developed in this suggested test are reported in Appendix II to this report.

Precision and Tolerance.—The Section on Precision and Tolerance has undertaken a study of the variations in the load, P.C.E. determination and reheat tests. The preparation of a manual of precision and tolerance methods for use by workers in refractories is also contemplated. The "brick-meter," a device for the exact measurement of brick between parallel plates developed by the American Refractories Institute Fellowship was recently used in a study of the variations in size of different types of refractories manufactured in the various producing districts. The data accumulated in this survey is being considered by the Section on Precision and Tolerance.

Heat Transmission.—The report on Definitions, Nomenclature, Symbols and Units for Heat Transmission recently prepared by the Committee on Heat Transmission of the National Research Council is being considered by the Section on Heat Transmission. Consideration is also being given to the calorimeter, hot plate, and heat-flow meter methods used in recent thermal conductivity measurements as possible standard tests. Standard methods of expressing results of conductivity measurements will be worked out with the standard tests.

Slagging Test.—The Section on Slagging plans to give further impetus to the study of the suitability of the new University of Illinois slag test for boiler furnace refractories. It has been definitely established that the mineralogical character of the slag-eroded face of the refractory is the same in this test and in service samples, providing the temperature of the furnace gases is the same in the two cases.

Temperature.—The Section on Temperature is engaged in the comparison of P.C.E. values obtained with various types of furnaces on identical samples of clay. These samples of clay, varying in P.C.E. value from about cone 20 to cone 38, are to be tested and a detailed report made upon the construction of the furnace and the procedure followed in making the test. It is hoped that this will furnish data leading to a standardization of the furnace for making P.C.E. determinations. Nine laboratories have agreed to make tests on these samples which are now being prepared.

The section is also making a review of all the available publications containing information relating to cone temperatures with the idea of recommending a standard series of temperatures corresponding to the various cones. No experimental work, however, is contemplated in this connection.

The recommendations appearing in this report regarding the tentative revision of the heating rate in the P.C.E. test of Method C 24 has been submitted to letter ballot of the committee, with the following result:

Item	Affirmative	Negative	Not Voting
PROPOSED TENTATIVE REVISION OF STANDARD			
Standard Method of Test for Softening Point of Fire-Clay Brick (C 24 – 28)	23	0	9

This report has been submitted to letter ballot of the committee, which consists of 29 members; 27 members returned their ballots, of whom 26 have voted affirmatively and one negatively.

Respectfully submitted on behalf of the committee,

L. J. Trostel,
Secretary.

G. A. Bole,
Chairman.

Editorial Note

The proposed tentative revision of the Standard Method of Test for Softening Point of Fire-Clay Brick was accepted for publication as tentative and appears on page 864.

APPENDIX I[1]

RECOMMENDED STOCK SHAPES AND SIZES OF BRICK AND TILE FOR MALLEABLE FOUNDRY REFRACTORIES.

The following are recommended stock shapes and sizes of brick and tile for malleable foundry refractories. These shapes and sizes are in accordance with the Simplified Practice Recommendation R 79 – 28 for Malleable Foundry Refractories of the U. S. Department of Commerce:

I. Door Opening Tile:

5 by 9 by 24 in.
5 by 13½ by 24 in.

II. Tap-Out Blocks:

Outside dimensions 7½ by 7½ by 9 in., with suitable flare from the hole to the face to allow room for the tapping rod and plugging up.

(*a*) One block to have a ¾-in. diameter hole for foundries using hand ladles.

(*b*) One block to have a 1-in. diameter hole for furnaces served with bull ladles.

III. Shapes for Side Walls, Bridge Walls, etc.:

Classification	Sizes, in.
9-in. straight	9 by 4½ by 2½
9-in. large straight	9 by 6¾ by 2½ (for breaking joints)
9-in. soap	9 by 2½ by 2¼
9-in. split	9 by 4½ by 1¼
No. 1 arch	9 by 4½ by (2½ tapered to 2⅛)
No. 2 arch	9 by 4½ by (2½ tapered to 1¾)
No. 1 wedge	9 by 4½ by (2½ tapered to 1⅞)
No. 2 wedge	9 by 4½ by (2½ tapered to 1½)

IV. Shapes for Bungs and Roofs:

Classification	Sizes, in.
No. 101 square bung	13½ by 4½ by 3
No. 102 angle bung	(13½ top, 12⅛ bottom) by 4½ by 3
No. 103 arch bung	13½ by 4½ by (3 tapered to 2⅝)
No. 104 arch angle bung	(13½ top, 12⅛ bottom) by 4½ by (3 tapered to 2⅝)
No. 105 arch bung	13½ by 4½ by (3 tapered to 2⅞)

V. Shapes for Round Stacks:

Circle Brick	Sizes, in.
24-in. circle	9 by 4½ by 2½
36-in. circle	9 by 4½ by 2½
48-in. circle	9 by 4½ by 2½
60-in. circle	9 by 4½ by 2½
72-in. circle	9 by 4½ by 2½
84-in. circle	9 by 4½ by 2½
No. 1 wedge	9 by 4½ by (2½ tapered to 1⅞)
No. 2 wedge	9 by 4½ by (2½ tapered to 1½)

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[1] These shapes and sizes are in accordance with Simplified Practice Recommendation No. 79–28 of the Department of Commerce and will be appended as information to the Standard Specifications for Clay Fire Brick for Malleable Furnaces With Removable Bungs and for Annealing Ovens (C 63–28) when the Book of A.S.T.M. Standards is next published.

APPENDIX II

A NOTE ON THE ABRASION TEST FOR SILICA BRICK

By Sandford S. Cole[1]

A method for determining the resistance of silica brick to abrasion has been developed by this laboratory which is a modification of the rattler test for paving brick. The test is performed on 10 brick in the manner and with the equipment described in the Standard Specifications for Paving Brick (C 7 - 15)[2] except that the cylinder is rotated only 20 minutes or 600 revolutions. The resistance of silica brick to abrasion is indicated by the percentage loss in weight and will vary to a certain degree with the porosity, crushing strength and modulus of rupture.

The curves in Fig. 1 show the abrasion loss, porosity, crushing strength and modulus of rupture from data obtained on samples of brick from the several producing districts which had marked differences in abrasion loss. The abrasion loss is shown to increase with the decrease in crushing strength and modulus of rupture. The porosity is not a positive index of abrasion resistance, but it may be said that if the porosity is low, a low abrasion loss may be anticipated.

Such a test would not be suitable for fire-clay brick since they are in an altered condition at elevated temperatures as evidenced by plastic flow.

This test for silica brick has been found to check quite closely with service data. It brings out the difference between brick which a porosity test would not show. The difference in values are so great that it is not difficult to perceive the better grade of brick. Brick of the same burn, grind, etc., have been found to give nearly identical results. The data given have been selected from some 75 tests and are typically representative of the variation of the abrasion, due to modulus of rupture, crushing strength and porosity.

This laboratory has tried the grinding wheel test of Harvey and McGee[3] with little success due to the variable results obtained. The use of the sand blast is believed to be unsatisfactory since the abrasion failure of silica in coke oven chambers and like service is due to tearing out of the grains by rubbing. The rolling effects of the rattler test do accomplish this.

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[1] Ceramic Engineer, The Koppers Co. Laboratories, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 126.

[3] F. A. Harvey and E. N. McGee, "Factors Affecting the Resistance of Silica Refractories to Abrasion," *Journal*, Am. Ceramic Soc., Vol. 7, No. 12, p. 895 (1924).

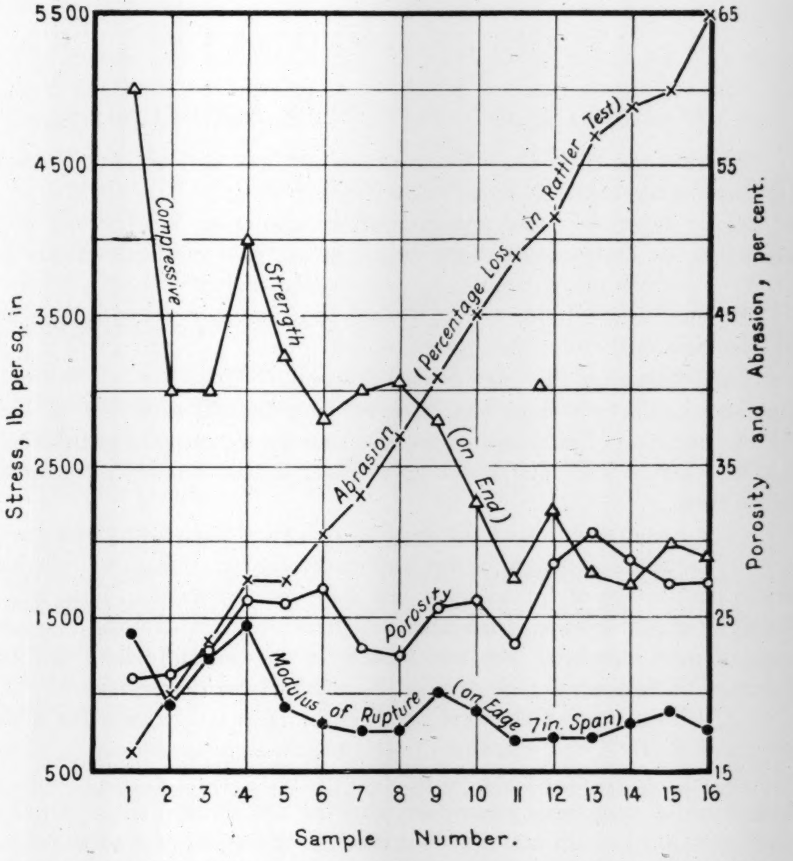

FIG. 1.—Relationship of Abrasion to Porosity, Compressive Strength and Modulus of Rupture of Silica Brick.

REPORT OF COMMITTEE C-9
ON
CONCRETE AND CONCRETE AGGREGATES

During the past year, Committee C-9 has had under consideration and investigation many important matters in its field, and in addition, its officers and sub-committee chairmen have given much attention to matters affecting organization and methods of carrying on its activities most effectively and productively.

It has been felt for several years that developments in the field of concrete and concrete aggregates have been so rapid as to require more attention on the part of this committee than has been devoted to them. The problem has been to keep in the forefront of those developments. To do so means speeding up the work and increasing the number of subjects under investigation and consideration at the same time.

The basic features of the general policy of the committee are:

1. Gradual reorganization and reduction in size to a relatively small committee of, preferably, not over 60 members. This will be brought about by the elimination of inactive members and the addition of new members who are leaders in the concrete field and in a position to take an active part in the work of the committee.

2. Limitation of the term of membership to provide for a slow rotation, so that new members may be added each year.

3. Sub-division of the work into projects, each of which bears a name and a designating number, and the assignment of each project to a section of a sub-committee under the direction of a section chairman. The committee believes that, with 60 active workers, each in charge of and responsible for at least one project, the progress of the work will be accelerated.

During the year the formation of a new sub-committee was authorized to deal with permeability tests. Next to the quality of the constituent materials, permeability is probably the most important factor in controlling the durability of concrete. A relatively small amount of investigational work has been carried out on this property, and what has been done by different investigators has involved the use of widely varying materials. It is felt that the development of suitable test methods is of paramount importance in encouraging researches on permeability.

Sub-Committees VII and VIII on Laboratory Tests of Concrete and on Field Tests of Concrete, respectively, are being merged into a single Sub-Committee on Tests of Concrete under the chairmanship of Mr. A. T. Goldbeck.

The committee recommends that the following revision in the Standard Methods of Making and Storing Specimens of Concrete in the Field (C 31 - 27) submitted jointly by Sub-Committees VII and VIII be accepted for publication as a tentative revision:

Section 4 (*a*).—Add the following sentence between the first and second sentences:

> When impracticable to obtain a representative sample from the concrete after it has been placed in the work, samples shall be taken as the concrete is being delivered at the point of deposit, care being taken to obtain a sample representative of the entire batch.

Section 6.—Designate this section as Paragraph 6 (*a*) and replace the first sentence reading as follows:

> Two to four hours after molding, the test specimens shall be capped with a thin layer of stiff neat-cement paste in order that the cylinder may present a smooth end for testing.

with the following two sentences:

> Specimens shall not be removed from the place of molding within 24 hours and during this time shall be protected from the elements by the same method of protection as is used for the portion of the structure which the specimens represent. If steel forms are used, the specimens may be capped with a thin layer of stiff neat-cement paste from 2 to 4 hours after molding in order that the cylinder may present a smooth end for testing.

Add a new Paragraph (*b*), reading as follows:

> (*b*) Where specimens are not capped in the field, they shall be capped before testing in such a manner that the ends are perfectly plane and at right angles to the axis of the cylinder. The material used for capping and the thickness of the cap shall be such that it will not flow under the load.

Sections 7 and 8.—Replace these sections, reading as follows:

> 7. At the end of 48 hours the test specimens shall be removed from the molds and buried in damp sand except in case the molds shown in Fig. 3 are used, when they may be buried in damp sand without removal of the mold, thus permitting shipping in the molds.
>
> 8. (*a*) The test specimens shall remain buried in damp sand until 10 days prior to the date of test. They shall then be well packed in damp sand or wet shavings and shipped to the testing laboratory, where they shall be stored either in a moist room or in damp sand until the date of test.
>
> (*b*) Should a 7-day test be required, the test specimens shall remain at the work as long as possible to harden and then shall be shipped so as to arrive at the laboratory in time for test on the required date.

(*c*) Test specimens shall be protected from drying after removal from damp storage and before testing.

with a new Section 7 reading as follows:

7. (*a*) At the end of 24 hours, test specimens shall be removed from the place of casting and, if desired, forms may be removed. Those specimens intended for laboratory control tests shall be placed under moist curing conditions at approximately 70° F. and maintained therein until tested.

(*b*) The specimens intended for field control tests shall be kept on the structure as near the point of sampling as possible and yet receive the same protection from the elements on all surfaces and in all respects as is given to the portions of the structure which they represent. Field control specimens shall be protected from injury while on the work. They shall be sent to the laboratory not more than 7 days prior to the time of test and while in the laboratory shall be kept in ordinary air at room temperatures until tested.

Two standard methods of test under the jurisdiction of Committee C-9 have, during the past year, been submitted to the American Standards Association for approval as American Standards under the Proprietory Sponsorship Method. These standard methods are the Test for Organic Impurities in Sands for Concrete (C 40 - 27) and the Test for Sieve Analysis of Aggregates for Concrete (C 41 - 24).

In view of the policy of the committee of sub-dividing its work, the record of its activities takes the form of reports and papers by members of the sub-committees, which have been submitted for comment and approval to the sub-committee and to the main committee. In line with that policy, individuals and groups of members of sub-committees have been urged to follow up investigations and render reports in the form of papers. Fewer final reports are included this year on account of the reorganization of the committee's work. The status of the work of each of the sub-committees is summarized under the activities of sub-committees.

ACTIVITIES OF SUB-COMMITTEES

Sub-Committee III on Unification of Specifications (W. A. Slater, chairman).—This sub-committee has under consideration proposed revisions of the 1924 Report of the Joint Committee on Concrete and Reinforced Concrete. This work has been divided into four projects, as follows:

1. Quality of concrete and materials for concrete (Chapters 3 and 4), assigned to R. B. Young and A. T. Goldbeck.
2. Proportioning and mixing (Chapter 5), assigned to F. R. McMillan and Sanford E. Thompson.
3. Conveying and depositing (Chapter 6), assigned to R. L. Bertin and H. F. Clemmer.

4. Forms and curing (Chapter 7), assigned to H. S. Mattimore and R. W. Crum.

The work is well under way and definite recommendations should be available during the coming year.

Sub-Committee IV, Editorial (F. B. Lysle, chairman).—This sub-committee is reviewing all standards and tentative standards under the jurisdiction of Committee C-9 with a view to improving form and diction, and clearing up any ambiguities which may exist. Its recommendations will be made chiefly in the years in which the Book of Standards is published.

Sub-Committee V on Definitions has been reorganized under a new chairman, F. E. Giesecke. This sub-committee will proceed with the work already in hand and will review all the terms of interest to this committee which appear in the Glossary of Definitions of Terms Appearing in A.S.T.M. Standards and Tentative Standards compiled by Committee E-8 on Nomenclature and Definitions.

Sub-Committee VI on Design of Concrete (R. B. Young, chairman).—This sub-committee has been carrying out comprehensive studies of methods for designing concrete to obtain a definite transverse strength, and considerable progress has been made. A report with recommendations is expected during the coming year. This sub-committee is also studying the method of designing concrete based on the "mortar-voids" theory, and is giving consideration to methods for securing concrete of high early strength.

Sub-Committee VII on Laboratory Tests of Concrete (A. T. Goldbeck, chairman).—This sub-committee joins with Sub-Committee VIII on Field Tests of Concrete in recommending the revisions, mentioned earlier in this report, in the Standard Method of Making and Storing Specimens of Concrete in the Field (C 31 – 27) for publication as a tentative revision.

The following summarizes the progress of this sub-committee on the principal topics considered during the year:

Sand Bearings.—A study has been made of data received from several sources including the New Hampshire State HighwayDepartment, the Portland Cement Association and the North Carolina State Highway Commission. As a result of this study a tentative conclusion has been reached that the use of sand bearings will give accurate results when the compressive strength of the concrete does not exceed 2500 lb. per sq. in. Their use is not advocated when the strength exceeds this amount. For high-strength concrete, there seems to be a decrease in strength results when the sand bearing method is employed as compared with the strength obtained when rigid, nonflowing capping material is used. This subject is still being investigated by the sub-committee, particularly with regard to the space between the retaining ring and the concrete cylinder, since it has been claimed that when this space is made small enough, the sand does not flow and accurate results are obtained.[1]

Flexural Strength Tests of Concrete.—Tests of the flexural strength of concrete have become important especially in the field of concrete for highway construction. Machines differing greatly in design are employed in various sections of the country and it has been found that varying results are obtained due, unquestionably in some instances, to defective design of the testing machine. The sub-committee has, therefore, made a theoretical study of the proper design of flexure testing machines and it has prepared the following summary of some of the features of certain machines now being used which are defective:

1. No attempt is made to prevent lateral restraint at the points of reaction or of load application. The consequence is that horizontal stresses are produced which should not be present and which may increase or decrease the fiber stress.
2. No proper means have been employed to prevent eccentricity of loading.
3. The load is measured at the end of a cable which operates over one or more pulleys, thus inducing friction and making the amount of the load somewhat uncertain.
4. Means have not been taken to insure a proper rate of load application.

The sub-committee has been in touch, through its chairman, with a similar committee of the American Association of State Highway Officials, which is arranging for a cooperative series of beam tests to be carried out with the view of standardizing the method of making the test.

The Portland Cement Association has already completed a comprehensive series of tests on beams loaded in different ways. The dimensions of the beams have been varied and it is felt by the sub-committee that sufficient data have resulted from these tests to warrant the formulation of a tentative standard method based on the "third point loading" method and such a standard will be proposed by the committee in the near future.

Flow Table Tests.—Work is being carried out in outlining a series of tests to investigate the properties of the flow table with the view of standardizing the method of making the test, particularly with regard to the height of fall.

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[1] For a discussion on the use of sand bearings, see page 329.—ED.

Sub-Committee VIII on Field Tests of Concrete (H. S. Mattimore, chairman).—As mentioned earlier in the report, this sub-committee is joining with Sub-Committee VII in recommending revisions in the Standard Methods C 31 - 27. The progress made in projects in charge of sections of this sub-committee are summarized as follows:

Method of Fabricating Flexure Test Specimens.—Mr. L. W. Teller, chairman of the section in charge of this problem, has reported on tests made at the U. S. Bureau of Public Roads. This report, entitled "A Study of the Effect of the Method of Fabrication on the Strength and Uniformity of Flexure Test Specimens of Concrete," appears as Appendix I. The program called for the construction of about 200 beams using angular coarse aggregates, and 200 beams using well rounded coarse aggregates. All specimens of each type were of the same proportions and the same consistency, and six methods of compacting were used, two by rodding, two by spading, and two by tamping. Twelve beams, two by each method, were made on any one day. Uniform curing was provided, and the specimens were tested after 28 days.

Method of Measuring Cores Drilled from Concrete Structure.—A section to study this question was formed recently under the chairmanship of F. H. Jackson. Its object is to standardize a method for measuring cores of hardened concrete taken from road slabs or other structures. A standard method for measurement is essential, as many highway specifications now require that the basis of payment for road slabs which show a thickness less than that required by the design, shall be determined by the measurement of cores extracted from the pavement. This section expects to investigate the several methods in use by different states, and to determine which is the most reliable, taking into consideration ease of application.

Report of Sub-Committee IX on Specifications and Methods of Tests of Aggregates (H. F. Clemmer, chairman).—This sub-committee has eight sections at work on as many projects. The progress of a number of these sections is given in the report of the sub-committee appended hereto.

Sub-Committee X on Deleterious Substances in Concrete (F. R. McMillan, chairman).—This sub-committee has seven projects now in the hands of sections. The Section on the Effect of Flat Particles on Concrete-Making Properties of Gravel has presented a report which appears as Appendix II to this report. The Section on Effect of Coal and Lignite in Sand for Concrete has also presented a report which appears as Appendix III to this report.

Sub-Committee XI on Apparatus for Testing (D. A. Abrams, chairman).—This sub-committee is carrying out a review of apparatus and testing equipment described or required by methods of tests sponsored by Committee C-9.

Sub-Committee XII on Measurement of Materials, Mixing and Placing Concrete (R. L. Bertin, chairman).—This sub-committee is of the opinion that specifications for measurement of materials, mixing, conveying and placing concrete should be based on some measurable property of the concrete in its plastic state, rather than to attempt to specify how the materials should be measured and the concrete mixed, transported and placed.

While it is not the intention of the sub-committee to disregard the influence of methods of manipulation, in its final reports, the endeavor will be made to draft specifications which will stipulate the condition of the resulting concrete at the various steps involved in its manufacture and placing.

The conditions or properties of fresh concrete on which it seems most logical to base specifications are (1) uniformity and (2) conformity to the proportions established by a method of design now being devised by Sub-Committee VI on Design of Concrete.

In order to control these conditions or properties, the sub-committee has undertaken to develop a practical field test to measure them. The method under investigation is a segregation test devised to reveal the amount of water, cement, fine and coarse aggregate contained in samples of fresh concrete collected at the mixer, at the point of delivery and from the structure.

Comparison of samples should indicate the uniformity of the concrete, and the amounts of materials indicated by the tests should enable the engineer to verify the correctness of proportions, as well as the quality of the aggregates, within a short time, and to correct the proportions or materials as the work progresses. This is generally left at present to the judgment of the inspectors and is not actually checked until field cylinders are tested 28 days after the structure is finished.

Several methods of making the segregation test are being developed and tried out by members of this sub-committee as well as outside laboratories and a definite method is being worked out for use in a series of coöperative tests by several laboratories.

The sub-committee, with the assistance of the Portland Cement Association, has completed its first project—compiling a bibliography on concrete mixing; the second project, a review of the articles, is now in progress. The sub-committee is also investigating ready mixed concrete; this work has not progressed far enough to submit a report at this time.

Sub-Committee XIII on Curing of Concrete (R. W. Crum, chairman).—This sub-committee has reviewed the present status of the art of curing and presents a list of current research investigations in this field. The report of this sub-committee is appended hereto.

Sub-Committee XIV on Workability of Concrete (J. C. Pearson, chairman).—This sub-committee is working on the development of apparatus for the measurement of workability.

Sub-Committee XV on Admixtures (George Conahey, chairman).—This sub-committee has paid particular attention this year to the collection of information on the claims of manufacturers with reference to admixtures produced by them. A progress report summarizing information made by the manufacturers concerning various admixtures is appended hereto.

Sub-Committee XVI on Elasticity and Volume Changes of Concrete (F. E. Richart, chairman).—This sub-committee is actively at work summarizing information on testing methods and existing data on such factors as modulus of elasticity, Poisson's ratio, plastic flow, and volume changes due to moisture, temperature and hardening. Work is also being done in the development of new methods of test.

Sub-Committee XVII on Conditions Affecting Durability of Concrete in Structures (E. Viens, chairman).—This sub-committee is collecting information on concrete failures with a view to determining the cause and remedy. Laboratory studies are being outlined, also, to study the effect of various factors in the proportioning and curing of concrete on its durability.

The recommendation appearing in this report has been submitted to letter ballot of the committee with the following results:

Item	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE REVISIONS OF STANDARD			
Standard Method of Making and Storing Specimens of Concrete in the Field (C 31 - 27).	50	3	8

This report has been submitted to letter ballot of the committee, which consists of 61 members; 46 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

STANTON WALKER,
Secretary.

CLOYD M. CHAPMAN,
Chairman.

EDITORIAL NOTE

The proposed tentative revision of the Standard Method of Making and Storing Specimens of Concrete in the Field was accepted for publication as tentative and appears on page 864.

REPORT OF SUB-COMMITTEE IX ON SPECIFICATIONS AND METHODS OF TESTS OF AGGREGATES

This sub-committee has eight sections at work on as many projects.

The Section on Effect of Stone Dust on the Properties of Concrete has prepared a report which appears as an Appendix to this report.

The Relation of Abrasion Test for Slag on the Concrete Making Properties of the Material:

This problem is being studied by a section under the chairmanship of Fred Hubbard. The section has prepared a method of procedure to be followed in their research work.

The concrete-making qualities of the material will be measured by the following:

1. Cross-Bending Strength,
2. Compressive Strength,
3. Wear Resistance,
4. Absorption.

Three samples of slag representing heavy, medium and light material as commercially produced are to be selected and shipped to the various cooperating laboratories by the following slag companies:

Buffalo Slag Co., Buffalo, N. Y.
Birmingham Slag Co., Birmingham, Ala.
Duquesne Slag Products Co., Pittsburgh, Pa.
France Slag Co., Toledo, Ohio.
Illinois Slag and Ballast Co., Chicago, Ill.
Standard Slag Co., Youngstown, Ohio.

These samples will represent eighteen lots of material, and the light, heavy and medium slag produced commercially by these six companies should provide as wide a range of abrasion and weight as likely to be encountered in practice. All slags are to be identified by number only. The method of handling the molten slag (pit, modified pit, or bank), the approximate age of slag at time of crushing, and the approximate tonnage produced are to be given.

The following grading of slag for the tests has been tentatively selected:

Passing a 2-in. sieve, retained on a	$1\frac{1}{2}$-in. sieve (square openings)	27	per cent
" " $1\frac{1}{2}$ " " " " "	1 " " " "	28	" "
" " 1 " " " " "	$\frac{3}{4}$ " " " "	14	" "
" " $\frac{3}{1}$ " " " " "	$\frac{3}{8}$ " " " "	21	" "
" " $\frac{3}{8}$ " " " " "	No. 4 " " " "	10	" "

This is a so-called "straight-line" grading. Each slag company is to screen the material and ship it in the proper quantities of each individual size.

Physical Tests of Slag.—The following physical tests will be made by each laboratory on each sample of slag:

1. Standard abrasion tests.
2. Modified abrasion tests. (Using ½ to 2-in. material corresponding to Grading A of the Tentative Method for Tests of Abrasion of Gravel (D 289 - 28 T)).
3. Unit weight determinations by the Standard Method of Test for Unit Weight of Aggregate for Concrete (C 29 - 27).
4. Absorption.

Chemical analyses will be made at the laboratory of the Standard Slag Co. only. It has been suggested that a specific gravity determination be made of a ½-cu-ft. sample in order to get more accurate results.

Concrete Tests.—In the concrete tests it is proposed that each laboratory use any brand of cement and any sand readily available that will meet A.S.T.M. standard specifications. A 1:2:3 mix by dry and rodded volume will be used throughout the tests. The concrete should contain enough water to produce a 1½ to 2½-in. slump, and, where a flow table is available, the flow should be recorded as well as the slump. In mixing, A.S.T.M. standard practice, as described in the Standard Methods of Making Compression Tests of Concrete (C 39 - 27) should be followed, although concrete produced in a small laboratory mixer will be permitted. Whatever method is used in mixing should be uniform for all materials.

Six cylinders, 6 by 12 in., for compression tests are to be made of each sample of slag, three to be tested at 28 days and three at 90 days. A sufficient number of beams is to be made for flexure tests to provide three breaks at 28 days and three at 90 days of age. It is preferred that the beams be 6 by 6 in. in section, although each laboratory may use any size of beam and any method of testing which may be available. The size of beams and method of testing should, of course, be noted on the report.

Wear Tests.—As there is no standard method of determining the resistance of concrete to wear, each laboratory is to make the wear tests in any way which may seem feasible. The committee, however, should be informed, prior to the making of the tests, what method is to be used.

The concrete tests will require the making of approximately six cylinders from 18 samples (108 cylinders in all), and two beams (3 breaks each) from 18 samples (36 total). These specimens will require approximately 14 sacks of cement, 1½ tons of sand and 2 tons of slag for each laboratory.

Soundness:

Four problems have been outlined for study by the section on soundness tests:

1. Determination of whether or not the action of sodium sulfate is purely mechanical.

2. Determination of effect of recrystalization of salt within the specimens to other forms.

3. Development of suitable quantitative measure of the results of accelerated tests.

4. Determine the relation between results of accelerated tests and actual freezing and thawing.

No work has been undertaken on Problem No. 1. Information furnished by the U. S. Bureau of Public Roads from work on this phase a few years ago showed a greater amount of calcium and magnesium in sodium sulfate solutions than in distilled water for corresponding periods with duplicate samples. The total amount of calcium oxide (CaO) found in these solutions was 30 to 36 per cent of the maximum amount soluble in the sodium sulfate solution and approximately 20 per cent of the maximum amount soluble in distilled water. Since the actual amount found is much less than the maximum solubility, it appears reasonably conclusive that the chemical action of sodium sulfate in this test would have little or no effect upon the test results.

Work has been undertaken on Problems Nos. 2 and 3 which should furnish conclusive results. Duplicate samples of two types of stone are to be tested by each of the five variations of the soundness test as well as freezing and thawing and wetting and drying. The feasibility of precipitation of the salt by varying the temperatures of the solution will also be examined. The samples will consist of 4000 g. of representative material which should give more concordant results than the ten pieces formerly used.

Solution of Problem No. 4 will to a certain extent follow the work of Problems Nos. 2 and 3, since a definite quantitative measure of the test will be necessary to correlate results by freezing and thawing and soundness.

Four laboratories have signified their willingness to cooperate in this work and should give sufficient data for conclusive results.

Respectfully submitted on behalf of the sub-committee,

H. F. CLEMMER,
Chairman.

APPENDIX

A DIGEST OF REPORT ON EFFECT OF STONE DUST ON THE PROPERTIES OF CONCRETE

By A. T. Goldbeck[1]

The following series of tests was conducted in the laboratories of the National Crushed Stone Association with the object of determining to what extent dust-coated stone might affect the properties of concrete.

Three types of stone were used, namely:

1. Limestone (No. 18),
2. Trap rock (No. 20),
3. Gneiss (No. 19).

These samples were made up into 1:2:3 concrete by loose, dry volume and the dust was first added to the moistened stone and thoroughly mixed with it in such a way as to produce a pasty coating. The concrete was then mixed by the use of shovels, the batch being sufficiently large to make one beam and two cylinders. This mixture was made up twice thereby producing two beams and four cylinders. The specimens were stored in a moist room at 70° F. and were tested at 28 days.

Strength Tests.—The beams were tested as simple beams under single, central loading and the troweled surface was placed in tension. Two breaks were obtained from each beam.

Wear Tests.—In addition to the strength tests, wear tests were made on broken beams of a portion of the series to determine if the dust had floated to the surface and had caused a weak surface layer. These wear tests were made by use of a special tool fitted in a drill press and held on the surface of the specimen under a pressure of 100 lb. while the tool was rotated at 275 r.p.m. The wear tool consisted of 1½-in. diameter emery wheel dressers arranged on a horizontal axle. This device produced very rapid wear on the surface of the concrete. The results of the strength and wear tests are given in Table I.

Conclusions.—The following may be stated as strong indications which may be drawn from the tests:

1. That the decrease in modulus of rupture due to dust is from 1 to 1½ per cent for each increase of 1 per cent in dust.
2. That the decrease in crushing strength is from 0 to 2 per cent for each increase of 1 per cent in dust up to the limit of 5.7 per cent of dust used in these tests.
3. That dust up to 5.7 per cent by weight of stone did not cause any serious decrease in the resistance to wear of the concrete.

As more dust was added an increased amount of water had to be used which resulted in an increased water-cement ratio. This probably accounts for the slight decrease in strength above noted for increasing percentages of dust.

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[1] Director, Bureau of Engineering, National Crushed Stone Association, Washington, D. C.

TABLE I.—EFFECT OF DUST-COATED STONE ON STRENGTH AND WEAR OF CONCRETE.

Test	Date Made	Clay and Silt in Sand, per cent	Dust in Stone, per cent	Weight of Concrete per Cubic Foot, lb.	Water Ratio	Flow	Compressive Strength, lb. per sq. in.	Modulus of Rupture, lb. per sq. in.	Wear in 15 Minutes, in.
No. 18-A.....	Oct. 16, '28	2.8	0.7	148.4	0.93	197	4040	753	0.27
No. 18-B.....	Oct. 16, '28	2.8	1.7	148.2	0.93	198	3900	744	0.30
No. 18-C.....	Oct. 16, '28	2.8	2.2	147.6	0.94	197	3930	714	0.26
No. 18-D.....	Oct. 16, '28	2.8	3.7	148.0	0.97	202	3735	700	0.31
No. 18-E.....	Oct. 16, '28	2.8	5.7	147.8	0.96	194	3610	705	0.30
No. 18-1......	Nov. 14, '28	2.8	0.7	148.0	0.90	198	3795	711	0.25
No. 18-2......	Nov. 14, '28	2.8	0.0	148.4	0.89	196	3780	694	0.26
No. 18-3......	Nov. 14, '28	0.0	0.0	149.0	0.88	201	4120	743	0.28
No. 19-A.....	Oct. 2, '28	2.8	0.7	.....	0.92	206	3250	673	....
No. 19-B.....	Oct. 2, '28	2.8	1.7	149.6	0.94	196	3290	678	....
No. 19-C.....	Oct. 2, '28	2.8	2.2	148.4	0.98	198	3260	680	....
No. 19-D.....	Oct. 2, '28	2.8	3.7	148.8	1.01	196	3280	673	....
No. 19-E.....	Oct. 2, '28	2.8	5.7	149.8	1.03	198	3240	631	....
No. 20-A.....	Oct. 12, '28	2.8	0.3	156.6	0.91	197	3870	740	....
No. 20-B.....	Oct. 12, '28	2.8	1.3	155.6	0.93	194	3860	738	....
No. 20-C.....	Oct. 12, '28	2.8	1.8	155.8	0.95	195	3740	705	....
No. 20-D.....	Oct. 12, '28	2.8	3.3	154.4	0.95	199	3640	711	....
No. 20-E.....	Oct. 12, '28	2.8	5.3	154.8	....	196	3550	694	....
No. 18-F.....	Oct. 18, '28	2.8	0.7	149.2	0.82	164	4300	762	....
No. 18-G.....	Oct. 18, '28	2.8	1.7	148.6	0.85	171	4240	729	....
No. 18-H.....	Oct. 18, '28	2.8	2.2	149.8	0.86	161	4170	718	....
No. 18-I......	Oct. 18, '28	2.8	3.7	148.2	0.86	163	3950	724	....
No. 18-K.....	Oct. 18, '28	2.8	5.7	148.8	0.89	168	4020	741	....
No. 19-F.....	Oct. 4, '28	2.8	0.7	152.0	0.91	165	3610	656	....
No. 19-G.....	Oct. 4, '28	2.8	1.7	150.6	0.86	170	3760	664	....
No. 19-H.....	Oct. 4, '28	2.8	2.2	151.6	0.89	171	3530	635	....
No. 19-I......	Oct. 4, '28	2.8	3.7	151.2	0.94	160	3510	631	....
No. 19-K.....	Oct. 4, '28	2.8	5.7	151.6	0.96	174	3460	642	....
No. 20-F.....	Oct. 10, '28	2.8	0.3	157.0	0.88	159	4370	781	....
No. 20-G.....	Oct. 10, '28	2.8	1.3	156.6	0.88	166	4040	746	....
No. 20-H.....	Oct. 10, '28	2.8	1.8	156.0	0.88	161	4300	736	....
No. 20-I......	Oct. 10, '28	2.8	3.3	155.4	0.90	161	4000	737	....
No. 20-K.....	Oct. 10, '28	2.8	5.3	156.0	0.92	164	3960	740	....

REPORT OF SUB-COMMITTEE XIII ON CURING OF CONCRETE

PRESENT STATUS OF KNOWLEDGE IN CURING OF CONCRETE

A large amount of inquiry is being directed into the curing of concrete at the present time. The sub-committee does not expect to be able to recommend methods of practice or specifications until the results of current research projects are coordinated and studied.

For the purpose of clarifying the situation the sub-committee offers the following statement as to its understanding of what is meant by the term "curing" of concrete and the results that may be expected from lack of "curing":

By good "curing" of concrete is meant the setting up of favorable conditions for chemical action during the setting and early hardening period.

The general opinion at the present time is that the most favorable conditions exist when the concrete is warm and when moist throughout. Temperatures that are regarded as favorable in practice range from 70° F. to somewhat above 100° F.

Our present knowledge of the behavior of portland cement and concrete while setting and hardening indicates that:

1. A maximum amount of cement will be hydrated; and
2. The concrete will be subjected to a minimum amount of volume change during the period of low strength.

There is also evidence that when improper or inadequate curing conditions prevail, the insufficient hydration of the cement will be revealed through low strength of the concrete and lack of durability with the passage of time, and that excessive cracking will result from the volume changes due to variations in temperature and in moisture content.

CURING METHODS

Water Control.—There are two general methods of controlling the moisture content of concrete during the curing period: namely, (1) the concrete is kept moist by the addition of water from the outside, and (2) methods are used for retention of the moisture contained by the concrete when placed.

Temperature Control.—In cement products plants and to some extent in structural work, temperature control is exercised as a curing measure. In paving work, temperature has not been controlled except incidentally. Present practice indicates that, whenever concrete is placed when the temperature is 40° F. or less, or is likely to be exposed to such temperature during the early hardening period, means should be employed to heat the concrete to a temperature of not less than

70° F. nor more than 130° F., and the air surrounding it should be maintained at a temperature of 50° F. or greater until the concrete has obtained sufficient strength to warrant its exposure to the prevailing temperature without injury.

At the present time no authoritative decision can be made as to the relative values of the various curing methods in use nor as to the particular conditions under which each of the methods may be most effective.

RESEARCH IN CURING

The research committee of the American Association of State Highway Officials in its 1928 report listed the following current investigations of curing of concrete among the highway departments:

U. S. BUREAU OF PUBLIC ROADS: Studies of Methods for Curing Concrete, Virginia Demonstration Road, Comparative Study of Wet Earth, Calcium Chloride and Sodium Silicate Curing of Concrete Pavements.

CALIFORNIA: Curing Tests of Concrete, Field Tests of Curing Concrete.

CONNECTICUT: Calcium Chloride Experiments in Quick Hardening of Concrete.

GEORGIA: Comparison of Methods of Curing Concrete.

ILLINOIS: Surface Curing of Concrete, Change in Pavement Surface During and After the Curing Period.

IOWA: Methods of Curing Concrete.

MARYLAND: Methods of Curing Concrete Roadway.

MINNESOTA: Calcium Chloride in Concrete, Field Curing of Concrete.

NEW JERSEY: Relative Merits of Different Methods of Curing Concrete Pavements.

NORTH CAROLINA: Effect of Using Different Curing Conditions on the Strength of Mortar.

OHIO: Curing of Concrete Pavements, Control of Cracks in Concrete Pavements.

RHODE ISLAND: Effect of the Use of Calcium Chloride on Strength of Concrete (*a*) as Surface Curing Agent, (*b*) Used Integral in Mix.

TENNESSEE: Curing of Concrete Pavements.

WASHINGTON: Effect of Alternate Wet and Dry Curing Periods on the Strength of Mortar, Calcium Chloride as a Curing Agent for Concrete.

WEST VIRGINIA: Mortar Compression Tests, Using Calcium Chloride and Calcium Magnesium Chloride.

The Highway Research Board of the National Research Council is engaged in making a correlation study of these projects as well as the literature on the subject, with the objects in view of drawing any authoritative conclusions that may be justified by the facts available, and of arranging for such additional research work as may be needed. Advance reports of this work will be available to Sub-Committee XIII.

Respectfully submitted on behalf of the sub-committee,

R. W. CRUM,
Chairman.

REPORT OF SUB-COMMITTEE XV ON ADMIXTURES

During the past two years Sub-Committee XV has devoted the major portion of its time to a study of commercial admixtures sold for the purpose of improving concrete. Studies carried out on the various materials and on the literature concerning them has led the sub-committee to the conclusion that admixtures may be classified into six groups, as follows:

1. Accelerators, such as those containing calcium chloride.
2. Pozzuolanic materials, such as trass, volcanic ash and blast-furnace slag.
3. Diatomaceous silica, such as Celite, Calatom and Diatomite.
4. Water-repellant materials, such as soaps and various stearates.
5. Inert fillers, such as lime, clay, talc, etc.
6. Miscellaneous cementing materials, such as natural cement and high early-strength portland cement.

The sub-committee has collected the names of 81 materials sold as admixtures and information concerning their nature, method of use, chemical composition and claims as to their action in concrete has been requested from manufacturers. All manufacturers of the admixtures considered by the sub-committee were circularized, but data were received from only a portion of them. The present report summarizes the information collected as a result of the questionnaire. *The sub-committee accepts no responsibility for the correctness of any statement in the report with reference to the value of any admixture: the statements are based entirely on information received from the manufacturer.*

Alberoyd (Alberene Stone Co., New York City). A dry powder quarried at Esmont, Virginia, to be added to the aggregate in the same manner as the cement. The manufacturer submitted the following chemical analysis as representative:

Silica	39.64	per cent
Alumina	12.60	"
Iron Oxide	4.42	"
Lime	4.05	"
Magnesia	27.66	"
Loss on ignition	10.87	"
Specific gravity	2.85	
Weight per cubic foot	82.50	lb.
Residue, No. 200 sieve	12.00	per cent

The manufacturer claims that Alberoyd acts as a lubricant, increases the workability of the concrete, and, because of its nature, increases the density of the concrete and consequently improves its water-tightness. It is claimed that, because it is a non-absorbent material which is practically inert chemically, it gives maximum workability without the use of excess water. It is stated by the manufacturer that tests show that no additional water is required up to 3 per cent of Alberoyd and that only 0.1 per cent additional water is required when Alberoyd is used in the amount of 4 per cent of the cement. It is claimed that Alberoyd does not reduce the strength of the concrete and that it gives a more uniform and smooth texture to the concrete.

In support of the claims, references are made to reports of tests from the E. L. Conwell and Co. testing laboratory, Philadelphia, Pa., Pittsburgh Testing Laboratory, and from a field report on the Stanton Plant of the Exeter Power Co. of Pittston, Pa.

Alkagel (American Algin Products Co., Duluth, Minn.).—A colloidal paste for addition to the mixing water. It is stated by the manufacturer that it is processed from algin which is the basic extract of several species of seaweed.

The manufacturer claims that Alkagel *A* is an "absolute alkali-proofing and waterproofing compound." It is claimed to "repel water, safeguard against frost action and resist the attacks of alkali and salt water crystals." Alkagel B_3 is stated to be an absolute waterproofing for mass concrete; Alkagel B_2 is also recommended for this purpose but is particularly designed as a waterproofing for stucco and thin coatings; Alkagel *E* is recommended for coatings where a hard, smooth surface is desired and is stated to "not only render the concrete waterproof but to stop the organic acids and salt water washes from eating away concrete floors, drains and linings."

The manufacturer claims that Alkagel has stood up as an absolute waterproofing compound under the severest tests. Reports of its use show in the main, according to the manufacturer, "insignificant surface wetting in spite of prolonged immersion in water, with noticeable increases in density and strength."

In support of the claims, reference is made to a report on tests of Alkagel Waterproofing Compounds made at the University of Wisconsin.

Anti-Hydro (Anti-Hydro Waterproofing Co., Newark, N. J.).—A liquid to be added to the mixing water. The manufacturer states that it is a compound of a number of organic and inorganic materials having for their base a calcium chloride solution to which a number of correctives have been added. It is claimed by the manufacturer that Anti-Hydro produces impermeability and a "stone-like hardness" in masonry, improves the workability and density of concrete, protects steel reinforcing from corrosion and accelerates the hydration of the cement.

In support of the claims, the manufacturer refers to reports from E. L. Conwell and Co. testing laboratories, Philadelphia, Pa., and the University of Michigan and to U. S. Bureau of Standards *Technologic Paper No. 3*, and to twenty-five years of continuous and successful performance in installations under guarantee and surety bond.

Aquagel (Silica Products Co., Kansas City, Mo.).—Appears on the market as a powdered material. The manufacturer prefers that it be mixed with the cement by grinding with the clinker, although it may also be added at the time of proportioning the concrete; in the latter case it is mixed dry with the cement before the water is added.

The following chemical analysis was submitted as typical:

Loss on ignition	6.0	per cent
Silica (SiO_2)	58.2	"
Alumina (Al_2O_3)	21.9	"
Iron oxide (Fe_2O_3)	3.8	"
Lime (CaO)	5.9	"
Magnesia (MgO)	2.4	"
Sulfur, chlorides and alkalies	1.8	"
	100.0	"

The manufacturer claims that Aquagel improves the workability, watertightness and curing of the concrete and that increased strength will be obtained when the same water-cement ratio is used.

In support of these claims, references are made to tests carried out by the Kansas City Testing Laboratories and to *Bulletin 102* of the Silica Products Co., Kansas City, Mo.

Barnsdall Admix (American Tripoli Co., St. Louis, Mo.).—Active meta-colloidal tripoli silica ground to a fine powder, 90 per cent passing a No. 200 sieve. It is to be added with the cement and aggregate.

The manufacturer submitted the following analysis as representative:

Silica	97.40 per cent
Alumina	0.15 "
Iron oxide	0.35 "
Lime	0.15 "
Magnesia	trace
Ignition loss	1.00 per cent
Weight of powder	55.00 lb. per cu. ft.
Water absorption by weight	52.00 per cent
Fusing point	3300° F.

The manufacturer states that this form of active silica absorbs calcium and magnesium salts and neutralizes the hydrated lime liberated by hydrolysis during the setting of the cement.

The manufacturer claims water-tightness, quick-hardening, workability with minimum water, uniformity, smooth surfaces, with no hair-checking, increased activity and hydration of the cement, greater ultimate strength and increased resistance to disintegration by acids, alkalies, alum, sugar, sea water, sulfur compounds and sulfates, industrial wastes, smoke and other corrosive gases, liquids, and solids.

In support of the claims, references are made to reports by testing laboratories and municipalities, testimonial letters, and successful use in the trade for the past five years.

Cal (North American Cement Corp., New York City).—A white powder which is added in the dry form to the cement and aggregate. Cal is stated by the manufacturer to be a calcium oxychloride, formed by the hydration of high-calcium quicklime with a calcium chloride solution. It is said to contain about 20 per cent of calcium chloride and about 80 per cent of hydrated lime.

The manufacturer claims for Cal that it combines in one material the accelerating effect of calcium chloride and the improvement in workability obtained from lime. In addition, it is also claimed, that the use of Cal permits a reduction in the amount of mixing water.

References are made to U. S. Bureau of Standards *Technologic Paper No. 174* and to *Bulletin 13* of the Structural Materials Research Laboratory, Lewis Institute, Chicago, Ill.

Calatom (The Calatom Co., Monterey, Calif.).—A dry powdered diatomaceous earth to be added dry with the cement and aggregates. The manufacturer states that its chemical composition may be expected to vary within the following limits:

Silica (ignited basis)	80 to 87 per cent
Alumina	7 to 10 "
Impurities (principally iron oxide)	not more than 5 "

Calatom is guaranteed to contain less than 7 per cent of moisture and to have an ignition loss of less than 7 per cent at the time of shipment. A part of the alumina is said to be a partially calcined and specially treated product added to increase the plasticity.

It is claimed by the manufacturer that Calatom "has the highest degree of plasticity of any admixture." The claims are also made that it will combine with the free lime of the cement, reduce the absorption of concrete and increase the tensile and compressive strengths in proportion to the water absorbed by the Calatom. The statement is also made that "Calatom, with low absorption, is better than other diatomaceous earths with high absorption."

In support of the claims, references are made to reports from the R. G. Osborne Laboratories, Los Angeles, Calif., and the Albert A. Hanks Laboratories San Francisco, Calif.

Celite (Johns-Manville Corp., New York City).—A grayish white powder of refined Plankton Marine diatomaceous silica, manufactured at Lompoc, Calif. It is very finely divided and light in weight. It is added dry with the cement and aggregate at the mixer or may be mixed with the cement at the mill.

The manufacturer states that the chemical composition varies over only a slight range and is within the following limits:

Silica	90 to 92 per cent
Impurities (alumina, iron oxide and other materials)	3 to 5 "
Loss on ignition	4 to 6 "

The manufacturer claims for Celite that it is a very finely divided siliceous mineral aggregate that makes concrete more workable and acts as a void filler to reduce the size of voids in the concrete. Because of the increased workability, it is claimed that the resulting concrete is made more uniform, free from honeycombs and waterproof. It is pointed out that the greater uniformity of concrete made with Celite reduces the cost of patching and finishing. The manufacturer also states that there are data which indicate that Celite reacts with the free lime of the cement. One of the prominent claims made for Celite, on account of the increased workability, is its advantage for use in brick mortars and stucco mixtures to correct the short working properties of portland-cement mortars. It is further claimed that Celite does not reduce the strength of the concrete. It has been in commercial use since 1916 and it is used in over 4,000,000 cu. yd. of concrete annually.

In support of the claims, references are made to the following published literature:

Pearson and Hitchcock, "A Penetration Test for the Workability of Concrete Mixtures with Particular Reference to the Effects of Certain Powdered Admixtures," *Proceedings*, Am. Soc. Testing Mats., Vol. 23, Part II, p. 276 (1923).

Pearson and Hitchcock, "Economic Value of Admixtures," *Proceedings*, Am. Concrete Inst., Vol. XX, p. 312 (1924).

G. W. Hutchinson, "Uniformity of Field Concrete," *Concrete*, October, 1925.

Smith and Conahey, "A Study of Some Methods of Measuring Workability of Concrete," *Proceedings*, Am. Concrete Inst., Vol. XXIV, p. 24 (1928).

George Conahey, "The Effect of Admixtures on the Water-Cement Ratio-Strength Relation of Concrete," *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 373 (1928).

George A. Smith, "The Measurement of Workability of Concrete," *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part II, p. 505 (1928).

T. C. Powers, "Concrete Studies at Bull Run Dam," *Proceedings*, Am. Concrete Inst., Vol. XXV, p. 388 (1929).

Gonnerman and Woodworth, "Tests of Retempered Concrete," *Proceedings*, Am. Concrete Inst., Vol. XXV, p. 344 (1929).

Colloy (Colloy Products Co., St. Louis, Mo.).—A colloidal gelatinizing, powdered, siliceous admixture, the usual recommended proportion, added dry, being 2 per cent by weight of cement.

The manufacturer states that the material is a colloidal silica, chemical, physical and microscopical analyses of which are available.

The manufacturer claims that recommended proportions can be used for obtaining either greater workability or for utmost economy with maintenance of required strength and workability.

In its recommended proportions, with fixed effective water-cement ratio and quantity of aggregate, the manufacturer claims a marked increase in yield or volume of "lubricant" paste resulting in greater workability and equal strength.

If additional aggregate is used in full proportion to the increase in volume of paste there results a negligible increase in workability although an increase in yield of concrete, in this case, the claim being greater economy in a mix designed for given strength and workability.

Dependent upon the object sought in the use of the admixture it is claimed that the product can be used to make feasible the placing of concrete of drier consistency, greater workability, water-tightness and apparent density, also greater uniformity of strength.

In support of the claims, the manufacturer states that data are available from government, state, municipal, university, private and commercial testing laboratories.

Co-Wa-Co (Co-Wa-Co Inc., New York City).—A liquid to be added to the mixing water or with the aggregate. The manufacturer did not furnish a chemical analysis of this material but stated "that it is of such a nature as to leave an insoluble residue in the concrete."

It is claimed by the manufacturer that Co-Wa-Co fills the pores of the concrete with insoluble, indestructible solids, producing greater plasticity and workability in the mass, and makes the concrete water-tight. It is stated that Co-Wa-Co contains no chlorides or other accelerating compounds and will not cause hair-cracks or corrosion of the steel.

In support of the claims, reference is made to tests carried out at Columbia University.

Fluresit (American Fluresit Co., Cincinnati, Ohio).—A paste for addition to the mixing water or, in some cases, to the aggregate. No chemical analysis of the material was furnished by the manufacturer.

The manufacturer claims that "it renders the concrete harder, waterproof, acid resistant, and increases the tensile and compressive strength and also gives the concrete workability." It is claimed to fill the pores with glass-like crystals which cause the hardening and waterproofing effect.

In support of the claims, references are made to tests carried out by H. C. Nutting Co., Cincinnati, Ohio, and by G. F. Gebhart, Armour Institute of Technology, Chicago, Ill.

Hydratite (A. C. Horn Co., Long Island City, N. Y.).—A paste to be added to the mixing water. The manufacturer states that it is an ammonium stearate and claims that it increases workability, decreases permeability and becomes an integral part of the concrete.

Hydrocide Integral Waterproofing (L. Sonneborn Sons, New York City).—Furnished either in the form of a powder or a paste. The manufacturer recommends that the powder be added with the aggregate and that the paste be added to the mixing water.

The powder is stated to consist of an intimate mixture of alkaline earth and metallic soaps. The following was submitted as a representative chemical analysis:

Hydrated lime	93	per cent
Calcium stearate	7	"

The paste, according to the manufacturer, "can be designated as a stable aqueous emulsion." The following was submitted as a representative chemical analysis:

Stearic acid	13.0	per cent
Colloidal clay	10.0	"
Solid sodium hydroxide	0.1	"
Water	75.9	"

It is claimed by the manufacturer that Hydrocide waterproofs concrete and mortar and increases its strength.

Loomite (W. H. Loomis Talc Corp., Gouverneur, N. Y.).—A very finely ground powder manufactured from a sound, crystallin, magnesium silicate rock. It is shipped as a dry powder and added dry with the cement and aggregate at the mixer.

The manufacturer submitted the following approximate chemical analysis as representative:

Magnesium silicate	78.71	per cent
Calcium silicate	12.00	"
Calcium carbonate	1.20	"
R_2O_3	1.70	"
Combined water	5.98	"

The manufacturer claims waterproofing, increased workability, yield, density, acid and heat resistance and increase in strength. Also for use in stucco and fattening cement mortar.

For proof of the claims, the manufacturer refers to tests made in his own laboratory and to reports from Lehigh University and Milton Hersey Co., Montreal, Can.

Master Builders Waterproofing (Master Builders Co., Cleveland, Ohio).—Furnished in three forms—a liquid, powder or paste. It is recommended that the liquid and paste be added to the mixing water and that the powder be mixed with the dry portland cement before the cement and aggregate are mixed. No information was furnished concerning the chemical analysis of this material.

Among the claims of the manufacturer are that "it is an integral method which waterproofs the entire body of the concrete or mortar, not merely the surface," "increases the hydration of the cement," and "deposits on the surface of the pores a permanent insoluble water-repellant coating which prevents the seepage of moisture through the pores in the concrete."

The liquid form is claimed to increase the initial strength of the concrete but no statement is made with reference to the effect of the powder or paste on the strength. It is pointed out that its use eliminates extra labor for mixing or handling the waterproofing operations. Its merit as a waterproofer is based on two factors: (1) it carries and introduces into the mix the same water-repellant materials that the paste and powder do; and (2) it increases the hydration of the cement, which is in itself a waterproofer, stimulating colloid formations which swell and close the capillary pores.

The names of completed jobs are given in support of the claims.

Medusa Waterproofing (Medusa Portland Cement Co., Cleveland, Ohio).—Is furnished either as a powder or as a paste. The powder is added dry with the cement and aggregate at the mixer or mixed with the cement at the mill. The paste is added to the mixing water. The manufacturer states that the powder is a calcium stearate and the paste an ammonium stearate.

It is claimed by the manufacturer that the powder makes concrete and mortar waterproof. The waterproofness is attained on account of the water-repellant properties of the powder which overcomes the capillarity of the concrete or mortar. With reference to the paste, it is claimed that it adds workability to the concrete or mortar as well as making them waterproof. It is stated that the paste, when distributed throughout the concrete or mortar by means of the mixing water, reacts with the lime of the cement to form a calcium stearate.

A list of buildings in which these materials have been used was submitted in support of the claims.

Pumicite (The Pumicite Co., St. Louis, Mo.).—A calcined pozzuolana in the form of a white powder. It is to be added to the portland cement in the plant or at the mixer.

The following chemical analysis was submitted as typical:

Moisture	0.06	per cent
Loss on ignition	4.95	"
Silica (SiO_2)	71.92	"
Iron Oxide (Fe_2O_3)	2.08	"
Alumina (Al_2O_3)	12.74	"

Lime (CaO)	0.82	per cent
Magnesia (MgO)	0.21	"
Sulfur (SO_3)	....	
Alkalies (Na_2O, K_2O, etc.)	7.22	"

It is claimed by the manufacturer that Pumicite adds strength by increasing the hydration of the cement; gives greater workability due to its flat crystallin structure; makes for denseness by filling voids, thereby increasing water-tightness; aids the curing by retention of moisture; makes improved surfaces, assists spouting and handling of concrete by prevention of segregation; largely prevents crazing and cracking due to less shrinkage in forms.

References for proof of the claims are made to reports from testing laboratories and testimonial letters from users.

Red Dog Diatomite (Atomite Corp., Portland, Ore.).—A finely divided diatomaceous earth to be added to the aggregate at the mixer.

The following chemical analysis was submitted by the manufacturer as representative:

Silica	84.59	per cent
Alumina	3.68	"
Iron oxide	1.68	"
Titanium oxide	0.08	"
Calcium oxide	0.84	
Magnesium oxide	0.70	"
Sodium and potassium oxide	2.15	"
Combined water	6.06	"

It is claimed that Red Dog Diatomite improves workability, water-tightness, prevents segregation and increases strength of lean mixes.

In support of the claims, reference is made to a report of the Smith, Emery and Co., Los Angeles, Cal., for the Indian Service, Coolidge Dam, San Carlos, Ariz.

R.I.W. Toxement and Toxmix (Toch Brothers, New York City.).—R.I.W. Toxement is supplied in powder and paste form and Toxmix as a liquid.

With reference to the composition, R.I.W. Toxement is stated to be a "colloidal double resinate and silicate of calcium and aluminum. It is composed of a basic calcium and magnesium silicate, colloidal barium sulfate and glycerides of a fatty acid." Toxmix is stated to be a "barium basic composition."

Toxement is stated to improve the workability and flowability of the concrete and by its action to bring about "a densification of the mix" and assure "proper and complete hydration." The paste is added to the mixing water and the powder to the cement.

Toxmix is stated to be an integral accelerator hardener and waterproofer. It is stated by the manufacturer that it "increases to a great degree the tensile and compressive strength of the mix and gives an accelerated action."

In support of the claims, a list of buildings in which the products have been used was submitted.

Solvay Calcium Chloride (Solvay Process Co., New York City).—Furnished to the job in flake form. It is dissolved in water and added to the mixing water.

Solvay Calcium Chloride is stated by the manufacturer to be a commercially pure product containing 78 per cent of calcium chloride, the remainder being principally water of crystallization.

The manufacturer claims that it accelerates the set and increases the early strength of the concrete, reduces the period of protection necessary in cold weather, increases the hydration of the cement, acts as a curing agent, increases the density of the concrete and adds to its waterproofness.

In support of the claims, references are made to the "Effect of Calcium Chloride in Mixing Water on Strength of Concrete," a pamphlet issued by the Portland Cement Association; Duff A. Abrams, "Calcium Chloride as an Admixture in Concrete," *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part II, p. 781 (1924); and a bulletin issued by the Solvay Sales Corp., entitled "The Uses and Advantages of Solvay Calcium Chloride."

Sulco Waterproofing and Konset (Sullivan Co., Memphis, Tenn.).—Supplied either as a liquid, paste or powder. The powder is for mixing with the cement and aggregate and the liquid and paste are for addition to the mixing water.

For Sulco Waterproofing the manufacturer claims that it becomes "an integral part of the mix, rendering the entire body of the cement water-tight and assuring permanently dependable results." It is stated that it forms a "perfect combination with the lime in cement, does not affect the set, but does tend to increase the tensile strength of the mass. It is claimed that Sulco Waterproofing Powder does not owe its "dehydrating" qualities to a chemical action, but simply fills the voids between the cement and sand particles.

For Konset it is claimed that it accelerates the set, hardens and waterproofs cement mixtures and saves approximately two-thirds of the usual time required for cementation. It is also supplied for coloring concrete and mortar. The manufacturer did not furnish a chemical analysis of these products.

Truscon Waterproofing Paste, Concentrated (The Truscon Laboratories, Detroit, Mich.).—A paste added to the mixing water or it may be added directly to the mixer without dilution. According to the manufacturer, it is substantially a combination of aluminum stearate and palmitate, made miscible with water in the form of a paste through the addition of a very small quantity of aqua ammonia. The compound and composition are patented.

Truscon Waterproofing Paste is claimed by the manufacturer to improve workability and insure greater compactness, density and thorough watertightness in the concrete. The introduction of Truscon, it is claimed, insures a greater stability in the concrete, particularly when subjected to conditions of alternate wetting and drying.

The following published articles are referred to in support of the claims:

A. H. White, "Volume Changes in Concrete," *Structural Conservation*, September–October, 1915.

Samuel R. T. Very, "Integral Waterproofing," *Architecture*, October–November, 1922.

A. H. White, "Integral Waterproofing for Concrete," *Industrial and Engineering Chemistry*, February, 1923.

A. H. White and J. H. Bateman, "Soaps as Integral Waterproofings for Concrete," *Proceedings*, Am. Concrete Inst., Vol. XXII, p. 535 (1926).

Miscellaneous Admixtures—No information was received from the manufacturers on the following admixtures:

A.B. Products, Acello, Adensite, Apco Mix, Aquabar, Aquatite, Arco, Are-O-Sol, Arrowlite, Black Fox, Calcel, Ceresit, Conwatco Mix, Crescrete, Dentonite, Dehydratine, Dia-Sil, Dryco Integral Mix, Featherstone, Ferno, Fluxite, Gar-Kem, G.F. Nos. 10, 11, and 12, Hydrocide, Kenellys, Killfreeze, Konox, Kosmotar, Nofreeze, Nonaqua, Novoid, Pacatome, Penetrite, Permantite, Pyrophyllite, Quickset, Rex Improver, Rocktite, Silimil, Speedit, Trass, Waterlock, Wilkinite and Winterpour.

Respectfully submitted on behalf of the sub-committee,

GEORGE CONAHEY,
Chairman.

APPENDIX I

A STUDY OF THE EFFECT OF THE METHOD OF FABRICATION ON THE STRENGTH AND UNIFORMITY OF FLEXURE TEST SPECIMENS OF CONCRETE

By L. W. Teller[1]

One of the problems which Sub-Committee VIII on Field Tests of Concrete of Committee C-9 has actively before it is the standardization of the flexure test for concrete. This is a matter of particular interest to those connected with paving concrete because of the growing use of this test as a basis for the opening of concrete pavements. The urgent need for standardization is apparent and there has already been a considerable amount of valuable discussion in the committee relative to the standardization of the equipment and procedure for testing such specimens. The matter of standardizing the procedure to be used in making the specimen is of equal importance since this procedure may influence the strength of the specimen to as great a degree as do the methods of testing.

It was with the idea of finding out just what effect methods of fabrication have on the strength and uniformity of concrete flexure specimens that the following work for the committee was undertaken at the laboratory of the U. S. Bureau of Public Roads at Arlington, Va. The program was necessarily restricted to those factors which seemed most likely to influence the strength of the specimen and, even though limited, it involved the making and testing of over four hundred beams.

Description of the Tests

Briefly, the program consisted of the fabrication and testing of 12 series of 34 flexure specimens each. The 12 series included 6 methods of fabrication, using concretes made with two coarse aggregates quite different in character physically.

The details of the program are set forth below.

Methods of Fabrication:

Method 1.—The concrete was placed in the mold in two layers and each layer was rodded 20 times with a $\frac{5}{8}$-in. diameter round steel rod. This rod was similar to those generally specified for fabricating compression specimens and is shown at the extreme left in Fig. 1.

Method 2.—This method was identical with method 1 except that each layer of concrete was rodded 50 times.

Method 3.—The concrete was placed in two layers and each layer was consolidated by cutting 20 times with vertical strokes of a special straight spade through which five large holes had been punched, the blade being held at right angles to the long axis of the specimen. The spade was made up for these tests and was not according to any particular specification. The blade was about 4½ in. wide and about 6 in. long. This tool is the second from the left in Fig. 1.

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[1] **Senior Engineer of Tests, U. S. Bureau of Public Roads, Washington, D. C.**

Method 4.—This method was identical with method 3 except that each layer of concrete was spaded 50 times.

Method 5.—The concrete was placed in two layers and each layer was tamped 45 strokes with a 2 by 2-in. square wooden tamper faced on the end with a steel plate of the same dimensions. The number of tampings was arbitrarily selected as it gave one stroke per square inch of surface of the area being tamped (approximately the same as in the molding of compression specimens). The tool is shown in Fig. 1, being the third from the left.

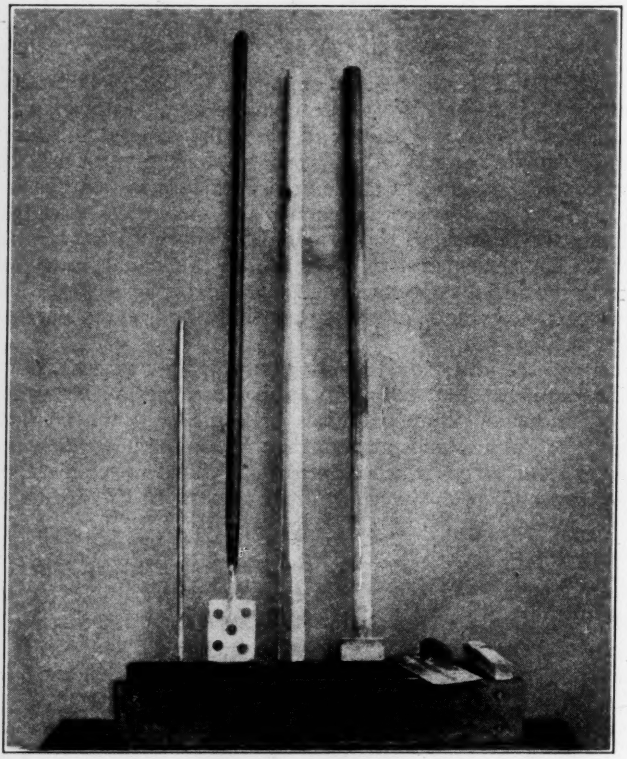

FIG. 1.—Equipment Used in the Investigation, Showing the Mold, Rod, Spade and Tamping Tool.

Method 6.—This method was identical with method 5 except that a tamper 4 by 4 in. square was used and each layer was tamped 10 times.

All of the specimens in this test were spaded along the sides and ends with the straight spade, the top was struck off with a wooden screed and the top surface smoothed off with a steel float. These tools are shown on top of the steel beam mold in Fig. 1.

Materials:

Mix.—The mix used was 1:2:3½ proportioned by dry rodded volumes.

Consistency.—The concrete was of stiff consistency; average flow of 125 on a 30-in. flow table.

Aggregates.—One-half of the specimens were made of concrete in which a very angular crushed stone was used as the coarse aggregate, and the other half were made of concrete in which a well-rounded gravel was used. The coarse aggregate was proportioned from three separate sizes in both cases and the maximum size was 1¼ in.

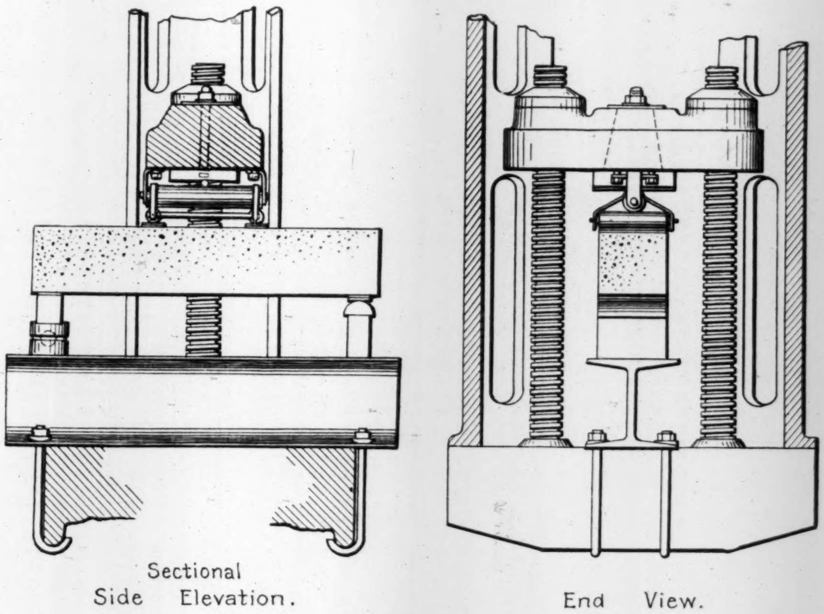

FIG. 2.—Set-up of Testing Machine Used in the Test.

The fine aggregate for all specimens was a very clean, high-grade concrete sand.

Water-Cement Ratio.—The water-cement ratio employed was 0.84 for the crushed-stone aggregate and 0.80 for the gravel aggregate.

Curing.—Specimens were left in the molds under wet burlap for 24 hours, after which they were placed in a damp room for 27 days.

Weather Effects.—Effects of variations in weather conditions were eliminated in so far as possible by fabricating two specimens by each of the six methods each day. Thus the specimens of one method are affected by exactly the same weather conditions as are those made by each of the other methods.

Method of Testing:

Age at Test.—The specimens were tested at 28 days.

Position of the Specimen.—The top surface as molded was in tension during the test.

TABLE I.—EFFECT OF METHOD OF MOLDING ON THE STRENGTH AND UNIFORMITY OF FLEXURE SPECIMENS OF CONCRETE.

ROUNDED AGGREGATE

Specimen No.	Method 1			Method 2			Method 3			Method 4			Method 5			Method 6		
	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average per cent
1	92.7	567	+ 6	92.0	511	− 5	92.1	569	+ 8	91.6	563	+ 3	92.5	545	− 1	92.4	597	+ 6
2	92.1	471	−12	92.1	432	−20	92.1	570	+ 8	91.9	513	− 6	91.6	458	−16	92.3	491	−13
3	92.8	507	− 5	93.0	400	−25	93.3	507	− 4	92.6	598	+10	92.9	538	− 2	92.1	541	− 4
4	93.8	522	− 2	93.9	526	− 2	92.5	540	+ 2	92.7	571	+ 5	91.5	572	+ 4	92.1	557	− 1
5	92.6	577	+ 8	93.1	625	+16	92.1	545	+ 3	92.2	603	+11	91.8	587	+ 7	90.9	603	+ 7
6	92.7	553	+ 3	92.7	611	+14	93.2	625	+18	91.6	553	+ 2	92.0	541	− 1	91.7	547	− 3
7	92.1	547	+ 2	92.5	551	+ 3	92.1	525	− 1	91.7	520	− 4	91.4	489	−11	92.6	547	− 3
8	91.8	501	− 6	92.4	637	+19	92.2	576	+ 9	92.3	551	+ 1	92.8	563	+ 3	93.1	587	+ 4
9	93.4	617	+15	92.7	569	+ 6	91.9	612	+16	91.8	541	− 1	91.2	639	+17	92.4	505	−10
10	92.9	583	+ 9	91.8	595	+11	92.4	569	+ 8	91.7	555	+ 2	92.0	609	+11	92.6	682	+21
11	92.8	529	− 1	93.0	522	− 3	92.2	516	− 2	92.0	561	+ 3	91.8	495	−10	92.1	486	−14
12	91.9	522	− 2	92.3	519	− 3	92.1	509	− 4	92.2	589	+ 8	92.0	576	+ 5	92.5	597	+ 6
13	93.7	619	+16	92.6	542	+ 1	93.1	559	+ 6	92.1	523	− 4	93.0	576	+ 5	92.5	590	+ 5
14	93.7	546	+ 2	92.5	546	+ 2	92.0	592	+12	93.3	499	− 8	93.1	537	− 2	92.1	568	+ 1
15	93.2	515	− 4	91.7	456	−15	91.8	455	−14	91.6	529	− 3	91.7	483	−12	91.7	506	−10
16	91.8	436	− 9	91.9	463	−14	92.2	452	−14	92.6	520	− 4	92.3	492	−10	91.7	571	+ 2
17	92.7	539	+ 1	93.4	591	+10	93.6	490	− 7	92.7	559	+ 3	92.6	563	+ 3	92.7	601	+ 7
18	92.2	548	+ 2	93.2	622	+16	92.5	501	− 5	92.8	559	+ 3	92.9	549	0	92.8	591	+ 5
19	92.7	444	−17	93.8	569	+ 6	92.4	543	+ 3	93.6	600	+10	92.1	583	+ 6	93.8	537	− 4
20	92.6	493	− 8	93.6	526	− 2	92.8	501	− 5	92.7	559	+ 3	93.6	573	+ 5	93.1	507	−10
21	92.7	643	+20	92.8	587	+ 9	93.1	555	+ 5	93.5	582	+ 7	93.1	585	+ 7	93.7	606	+ 8
22	92.8	660	+23	92.9	592	+10	92.8	541	+ 2	93.7	528	− 3	93.8	605	+10	93.8	614	+ 9
23	93.1	578	+ 8	93.0	569	+ 6	92.0	492	− 7	92.9	549	+ 1	92.8	475	−13	92.8	613	+ 9
24	93.2	475	−11	93.2	616	+15	93.3	477	−10	91.9	547	+ 1	92.6	500	− 9	93.9	543	− 3
25	93.3	515	− 4	94.1	433	−19	93.0	538	+ 2	93.3	476	−12	92.9	547	0	92.2	491	−13
26	92.6	472	−12	93.1	490	− 9	93.0	462	−12	93.0	532	− 2	92.4	435	−21	92.8	589	+ 5
27	....	535	0	....	521	− 3	....	516	− 2	....	500	− 8	....	486	−11	....	547	− 3
28	....	521	− 3	....	452	−16	....	490	− 7	....	537	− 1	....	541	− 1	....	579	+ 3
29	92.2	583	+ 9	92.8	569	+ 6	92.0	551	+ 4	92.6	557	+ 2	92.3	563	+ 3	93.7	569	+ 1
30	92.7	472	−12	92.8	551	+ 3	92.0	482	− 9	91.9	501	− 8	92.6	635	+16	92.8	475	−15
31	92.7	590	+10	93.0	597	+11	93.1	576	+ 9	93.7	603	+11	92.3	569	+ 4	93.8	577	+ 3
32	92.7	533	0	93.3	583	+ 9	93.5	549	+ 4	91.5	606	+11	92.0	595	+ 9	92.8	613	+ 9
33	92.8	477	−11	91.7	443	−17	91.8	461	−13	93.0	454	−17	92.4	554	+ 1	92.5	493	−12
34	92.8	492	− 8	93.5	442	−18	92.9	489	− 7	92.7	456	−16	92.0	561	+ 2	93.2	579	+ 3
Average	92.7	535	8	92.8	537	10	92.8	528	7	92.5	544	6	92.4	548	7	92.6	562	7

Testing Apparatus.—A universal testing machine was used operated by a hand wheel using the set-up shown in Fig. 2. As will be noted the middle third of the span was subject to a constant bending moment.

The specimens were 6 by 6 by 30 in. in size. The span used was 27 in. One break was obtained for each specimen.

TEST DATA

Tables I and II give all of the test data, Table I containing the data for the beams of gravel concrete (rounded aggregate) and Table II corresponding data for those of crushed-stone concrete (angular aggregate). The weight of each specimen and its modulus of rupture are given. The average modulus of rupture was computed for all of the specimens made by each method and the percentage of variation of each modulus of rupture value from this average was computed and entered in the table opposite the modulus of rupture value. These variations are averaged at the foot of the column.

TABLE II.—EFFECT OF METHOD OF MOLDING ON THE STRENGTH AND UNIFORMITY OF FLEXURE SPECIMENS OF CONCRETE.

ANGULAR AGGREGATE

Specimen No.	Method 1			Method 2			Method 3			Method 4			Method 5			Method 6		
	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent	Weight, lb.	Modulus of Rupture, lb. per sq. in.	Variation from Average, per cent
1	94.5	583	+ 4	94.5	577	− 1	94.0	496	−11	94.4	641	+15	93.6	646	+12	92.5	611	0
2	95.2	534	− 4	93.5	520	−10	94.6	548	− 2	94.6	541	− 3	94.3	641	+11	94.1	628	+ 3
3	94.1	462	−17	94.3	618	+ 7	93.5	497	−11	93.9	653	+17	93.6	601	+ 4	94.0	567	− 7
4	93.9	496	−11	94.0	565	− 3	94.5	566	+ 1	94.0	575	+ 3	93.9	622	+ 7	94.7	615	+ 1
5	94.7	555	− 1	94.1	562	− 3	94.8	476	−15	94.6	494	−11	94.5	562	− 3	93.9	687	+12
6	95.3	626	+12	94.7	521	−10	94.5	612	+ 9	94.5	492	−12	94.3	565	− 2	94.1	649	+ 6
7	95.0	560	0	94.7	533	− 8	95.4	532	− 5	95.4	517	− 7	94.1	556	− 4	94.3	580	− 5
8	94.2	518	− 7	94.0	623	+ 7	94.6	528	− 6	94.2	570	+ 3	94.7	492	−15	94.7	623	+ 2
9	94.9	618	+11	94.9	501	−14	95.3	602	+ 8	94.4	510	− 8	94.1	591	+ 2	94.2	628	+ 3
10	95.2	432	−23	94.7	573	− 1	94.6	587	+ 5	94.8	616	+11	94.6	605	+ 4	94.2	757	+24
11	94.3	547	− 2	95.0	613	+ 6	94.2	577	+ 3	93.7	561	+ 1	94.4	577	0	94.3	657	+ 8
12	94.2	579	+ 4	93.8	685	+18	94.7	631	+13	94.1	553	− 1	94.0	596	+ 3	94.0	623	+ 2
13	93.8	675	+21	94.7	570	− 2	94.2	513	− 8	93.9	485	−13	93.5	575	− 1	93.9	553	− 9
14	94.7	587	+ 5	94.2	[a]345	..	94.3	617	+10	94.0	566	+ 2	93.9	545	− 6	93.4	531	−13
15	94.5	667	+20	93.6	650	+12	93.2	532	− 5	94.1	545	− 2	93.7	551	− 5	93.6	602	− 1
16	94.2	529	− 5	93.9	643	+11	93.8	512	− 9	93.9	567	+ 2	94.0	553	− 4	93.6	658	+ 8
17	93.8	571	+ 2	94.6	638	+10	94.0	600	+ 7	94.3	555	0	93.7	627	+ 8	94.0	559	− 8
18	94.4	445	−20	94.7	597	+ 3	93.2	595	+ 6	94.1	542	− 3	94.4	655	+13	93.6	667	+ 9
19	94.4	643	+15	94.9	540	− 7	94.5	628	+12	94.4	542	− 3	94.7	625	+ 8	94.6	667	+ 9
20	94.9	621	+11	95.0	673	+16	94.1	628	+12	94.0	607	+ 9	94.4	567	− 2	94.7	...	..
21	94.5	495	−11	94.8	532	− 8	94.6	570	+ 2	94.8	561	+ 1	94.3	547	− 6	93.7	532	−13
22	94.8	538	− 4	94.6	562	− 3	94.8	477	−15	94.3	553	− 1	94.1	551	− 5	94.7	591	− 3
23	94.5	602	+ 8	94.8	533	− 8	95.4	617	+10	95.4	571	+ 3	94.9	480	−17	94.4	536	−12
24	94.6	618	+11	95.1	538	− 7	94.4	537	− 4	95.6	623	+12	94.9	607	+ 5	93.8	631	+ 3
25	95.0	585	+ 5	94.4	546	− 6	94.5	420	−25	94.7	573	+ 3	94.3	579	0	94.4	634	+ 4
26	95.4	544	− 3	93.8	639	+10	94.4	[a]371	..	95.2	536	− 4	94.3	550	− 5	94.7	635	+ 4
27	95.2	501	−10	95.1	619	+ 7	94.0	663	+18	94.8	523	− 6	94.6	615	+ 6	95.7	551	−10
28	94.3	423	−24	94.9	637	+10	94.1	583	+ 4	94.3	642	+15	94.3	590	+ 2	94.6	548	−10
29	94.3	625	+12	92.9	536	− 8	94.4	599	+ 7	93.9	570	+ 3	94.7	681	+18	94.9	558	− 9
30	93.8	597	+ 7	94.3	535	− 8	94.5	527	− 6	93.9	639	+15	94.5	605	+ 4	94.4	611	0
31	94.8	551	− 1	94.8	546	− 6	94.4	552	− 1	94.4	535	− 4	95.3	541	− 7	93.9	637	+ 4
32	94.0	571	+ 2	95.0	612	+ 6	94.4	572	+ 2	94.4	443	−20	95.2	520	−10	94.9	720	+18
33	95.3	...	..	95.6	522	−10	95.2	521	− 7	94.1	440	−21	94.9	545	− 6	94.3	549	−10
34	94.2	500	−10	94.6	571	− 2	94.5	555	− 1	94.2	553	− 1	94.3	521	−10	94.6	563	− 8
Average	94.6	558	9	94.5	580	7	94.4	560	8	94.4	556	7	94.3	579	6	94.2	611	7

[a] Not included in average.

These data are summarized for the six methods of fabrication as follows:

	Rounded Aggregate						Angular Aggregate					
	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6	Method 1	Method 2	Method 3	Method 4	Method 5	Method 6
Average modulus of rupture, lb. per sq. in.	535	537	528	544	548	562	558	580	560	556	579	611
Average variation from the average, per cent	8	10	7	6	7	7	9	8	8	7	6	7
Average weight of specimen, lb.	92.7	92.8	92.8	92.5	92.4	92.6	94.6	94.5	94.4	94.4	94.3	94.2

OBSERVATIONS OF THE OPERATORS

Before passing to a discussion of the data just presented there were certain practical observations made regarding the use of the various methods which are of considerable importance in making comparisons.

Comparing methods 1 and 2 the additional rodding specified for the latter method added but little to the total labor required to make the specimen. The operator had the impression that better compaction was obtained with the additional rodding.

The spading required in methods 3 and 4 seemed to stiffen up the concrete and gave it a well-mixed appearance. It was more difficult to force the spade down along the mold in the case of these two methods than with any of the others and there appeared to be more resistance to screeding the surface, particularly with method 4.

Method 5 showed a tendency to stiffen the concrete although this was not nearly so marked as in the case of methods 3 and 4. The small tamper used in this method did not operate to produce a plane through the specimen where the two layers of concrete came together.

With method 6 there was a decided tendency to form a plane between the two layers of concrete. The large tamper did not distribute the concrete well but a marked tamping action was apparent. It seemed that there was more effect from variations in the force of the blow struck in this than in any of the other methods employed. The large tamper was difficult to manipulate skillfully.

DISCUSSION OF THE TEST DATA

From the standpoint of the strength of the specimens obtained with the various methods the data indicate that there is little difference between the first five methods. The large tamper used in the sixth method, however, seems to give somewhat greater strength and this is particularly noticeable in the case of concrete containing the angular aggregate.

An examination of the data for uniformity based on the variations of the individual specimens from the averages for the various series shows that about the same average variation and about the same dispersion obtains for all of the six methods. The only exception is in the data for method 2 in Table I (rounded aggregate). Here, for no obvious reason, there are an unusual number of variations of the order of 15 per cent. In general, it may be said that the uniformity of the strength data does not seem to be affected to any important degree by the methods of fabrication used in these tests.

It was hoped that the weights of the specimens would reflect the degree of compaction obtained by the various methods since all of the specimens were made in accurately machined steel molds which have the same volumes within close limits. The weights are a measure of the average density of the specimens but some of the methods used did not give specimens of uniform density. This was particularly noticeable in the case of the large tamper (method 6) where the angular aggregate was used. The specimens were not thoroughly compacted in the corners and this seems to be the explanation for the fact that this group showed the lowest average weight. These same specimens showed the highest average strength of any in which this concrete was used and this was probably due to the compaction obtained in the critical section by the use of the large tamper.

From observations made during these tests the rodding and spading methods are more apt to give specimens which appear to have uniform density than are the tamping methods.

Considered from the standpoint of practical operation, there are arguments for both the spading and the rodding methods.

It is necessary to spade the specimen along the sides and ends and if the same tool would suffice for compacting the specimen then only one tool need be taken on the job.

On the other hand the rodding of specimens is well established and the rods used are easy to procure. There are also advantages to the use of the same tools for the fabricating of both compression and flexure specimens.

So far as ease of manipulation is concerned, it is not believed that there is any choice between the rod and the spade.

Tamping methods are not believed to be as satisfactory as rodding or spading because, in addition to the possibility of less uniform specimens, the force applied by the operator will have more effect than will be the case with a sharp edged or pointed tool.

CONCLUSIONS

The following conclusions seem justified by the data obtained in this investigation:

1. That both the rodding and spading methods used are equally satisfactory so far as strength, uniformity and ease of fabrication are concerned.
2. That the additional manipulation of methods 2 and 4 over that of methods 1 and 3 results in little or no improvement in the specimens obtained.
3. That the tamping methods are not as satisfactory as are the rodding or spading methods.

APPENDIX II

EFFECT OF FLAT PARTICLES ON CONCRETE-MAKING PROPERTIES OF GRAVEL

By Stanton Walker[1] and C. E. Proudley[2]

Early specifications commonly required that gravel be "free from flat and elongated pieces." Engineers soon realized that it was only in rare instances that such a specification could be complied with literally, and the need was felt for definite information on the effect of such materials in concrete. In the absence of specific information, the clause "free from injurious amounts, etc." was substituted, and, in a few cases, arbitrary limits based on the judgment of the engineer were placed in specifications.

Laboratory researches and field observations have increased our general knowledge of concrete and concrete materials, but little or no specific information on the effect of flat particles on the concrete-making properties of aggregates has been brought out. This report gives the results of a number of miscellaneous tests which show the effect of flat particles in gravel on the compressive and flexural strength of concrete and also includes studies of the surfaces of concrete slabs and of the physical characteristics of the aggregate.

The tests were carried out in the Research Laboratory of the National Sand and Gravel Association.

Materials

The gravel was dredged from one of the Great Lakes and washed and screened in a modern plant situated on land. It was separated into "round" and "flat" particles by hand picking, any particle with a length of five or more times the thickness being considered as "flat." The round particles consisted of a mixture of miscellaneous rock types; the flats included a considerable amount of rather hard sandstone, schist, miscellaneous rocks and a small percentage of shale. An average sample of the gravel had a specific gravity of 2.58 and an absorption of about 1 per cent.

The gravel used in the strength and slab tests was graded as follows:

	Amounts Coarser Than Each Size, per cent by weight		
	¼ to 2¾-in. Size Gravel		¼ to ¾-in. Size Gravel Used in Strength Tests
Size of Screen or Sieve	Used in Strength Tests	Used in Slabs	
No. 8 (square)	...	...	88
No. 4 (square)	...	100	78
¼-in. (round)	100	...	..
⅜-in. (square)	...	...	19
¾-in. (round)	85	80	1
1½-in. (round)	45	40	0

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[1] Director, Engineering and Research Division, National Sand and Gravel Assn., Washington, D. C.

[2] Assistant Director, Engineering and Research Division, National Sand and Gravel Assn., Washington, D. C.

The sand was well-graded concrete sand consisting of angular quartz grains from the Massaponax Sand and Gravel Corp., Bowie, Md. The cement was furnished by the Pennsylvania-Dixie Cement Co. from its plant at Bath, Pa. Both the sand and cement met the requirements of the specifications of the American Society for Testing Materials and other common specifications.

TEST METHODS AND RESULTS

Abrasion Tests.—Deval abrasion tests were made in accordance with the Tentative Method of Test for Abrasion of Gravel (D 289 - 28 T) of the American Society for Testing Materials,[1] using three samples proportioned by screens with circular openings according to Grading *A*. The three samples consisted of (1) 100 per cent round particles, (2) 70 per cent rounds and 30 per cent flats, and (3) 100 per cent flats.

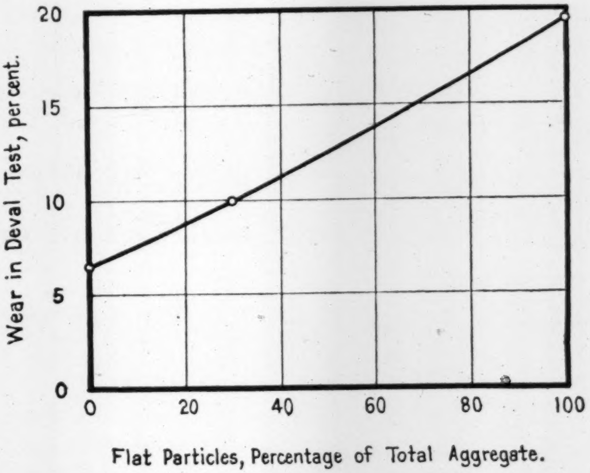

FIG. 1—Effect of Flat Particles on Resistance of Gravel to Abrasion.

The test requires that a 5000-g. sample of gravel composed of 25 per cent of each of four sizes ($\frac{1}{2}$ to $\frac{3}{4}$ in., $\frac{3}{4}$ to 1 in., 1 to $1\frac{1}{2}$ in., and $1\frac{1}{2}$ to 2 in.) be revolved in a Deval abrasion cylinder at 33 r.p.m. for 10,000 revolutions, with six cast-iron balls $1\frac{7}{8}$ in. in diameter added as an abrasive charge. The amount passing a No. 12 sieve is used to compute the percentage of wear. The results of these tests have been plotted in Fig. 1 and are as follows:

GRAVEL		
ROUND PARTICLES, PER CENT	FLAT PARTICLES, PER CENT	PERCENTAGE OF WEAR IN DEVAL ABRASION TEST
100	0	6.5
70	30	9.9
0	100	19.5

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 940 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 512.

The Deval tests show, as would be expected, a higher percentage of wear for the flats than for the rounds. The impact action of the cast-iron balls, added as an abrasive charge, evidently was more effective in the case of the thin pieces than in the case of the round ones. The curve in Fig. 1 is of interest in indicating that the percentage of wear in the Deval abrasion test is approximately proportional to the amount of flats in the gravel.

Soundness Tests.—Accelerated soundness tests were made separately on the flat and round particles from different sizes of gravel. Except for the size of sample, the tests were carried out in accordance with the Proposed Method of Test for Soundness of Coarse Aggregate (Sodium Sulfate Soundness Test) published as information in Appendix II to the 1928 report of Committee C-9 on Concrete and Concrete Aggregates.[1] Samples of 1250 g. of each of the four sizes used in the Deval abrasion tests were subjected to five alternations of sodium sulfate treatment. After the five alternations, the four sizes were recombined and, without removal of the sodium sulfate with which the gravel was impregnated, subjected to the Deval abrasion test for comparison with

TABLE I.—RESULTS OF TESTS ON GRAVEL CONCRETE.

Coarse aggregate: Lake gravel dredged from Great Lakes.
Fine aggregate: Concrete sand from Massaponax Sand and Gravel Corp., Bowie, Md.
Specimens cured in moist room until time of test.
Values given in columns 1 and 2 are the average of 5 tests made on different days; values given in columns 3 and 4 are the average of 3 tests made on different days.
Compression tests made on 6 by 12-in. concrete cylinders.

	$\frac{1}{4}$ to $2\frac{3}{4}$-in. Size Gravel		$\frac{1}{4}$ to $\frac{3}{4}$-in. Size Gravel	
	0 Per Cent Flats	10 Per Cent Flats	0 Per Cent Flats	14 Per Cent Flats
	1	*2*	*3*	*4*
Date Made	Jan. 5, '29, to Jan. 22, '29	Jan. 5, '29, to Jan. 22, '29	Feb. 1, '29, to Feb. 5, '29	Feb. 1, '29, to Feb. 5, '29
Proportions:				
By weight	$1:2:3\frac{1}{2}$ 1:2.38:4.22	$1:2:3\frac{1}{2}$ 1:2.38:4.22	$1:2:2\frac{1}{2}$ 1:2.38:3.02	$1:2:2\frac{1}{2}$ 1:2.38:3.02
Water-Cement Ratio	0.65	0.65	0.64	0.65
Slump, in	4.0	3.5	4.0	4.0
Unit Weight of Concrete, lb. per cu. ft.:				
Beams	151.0	151.5	146.5	147.0
Cylinders	151.5	151.5	148.0	148.5
Density, ratio of solids to apparent volume of concrete:				
Beams	0.85	0.85	0.81	0.81
Cylinders	0.85	0.85	0.82	0.82
Cement, per cent by volume of concrete:				
Beams	23.2	23.2	26.3	26.4
Cylinders	23.2	23.2	26.6	26.5
Compressive Strength, lb. per sq. in.:				
7 days	2930	3050	....	....
28 days	4310	4260	5090	4880
3 months	4820	4860	....	....
Flexural Strength (Modulus of Rupture), lb. per sq. in.:				
7 days	580[a]	570[a]	....	....
28 days	680[a]	700[a]	810[b]	830[b]
3 months	740[a]	760[a]	....	....

[a] Average of two breaks from each beam. Beams were 6 by 6 by 30 in. and were tested under center loading using an 18-in. span.

[b] Average of two breaks from each beam. Beams were 4 by 6 by 30 in. and were tested under center loading using an 18-in. span.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 361 (1928).

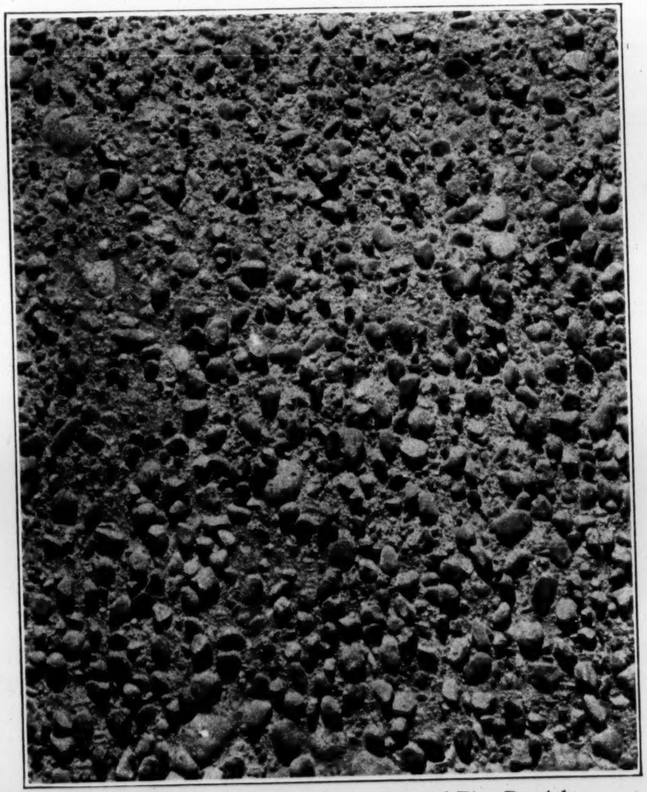

FIG. 2.—Slab Containing 0 Per Cent of Flat Particles.

Gravel graded $\frac{1}{4}$ to $2\frac{3}{4}$ in. Mix 1:2:$3\frac{1}{2}$ by weight. Slump about 3 to 4 in. Mortar disintegrated to depth of about $\frac{3}{8}$ in. from surface of slab by use of Con-Tex.

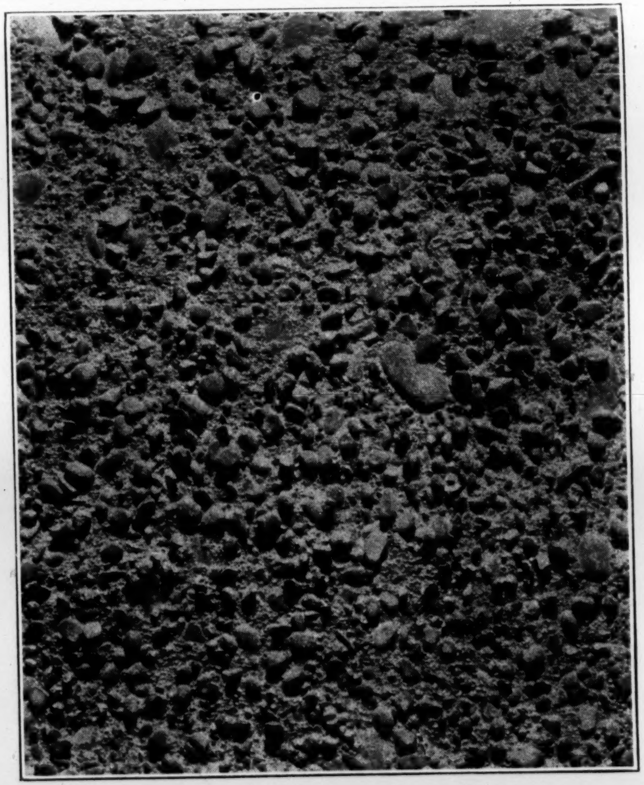

FIG. 3.—Slab Containing 15 Per Cent of Flat Particles.

Gravel graded $\frac{1}{4}$ to $2\frac{3}{4}$ in. Mix 1: 2:$3\frac{1}{2}$ by weight. Slump about 3 to 4 in. Mortar disintegrated to depth of about $\frac{3}{8}$ in. from surface of slab by use of Con-Tex.

the results of tests on the untreated samples. Each alternation consisted of drying the sample at a temperature of about 212° F. for 4 hours, and immersing it in a saturated solution of sodium sulfate (Na_2SO_4) at room temperature for 20 hours, and again drying for 4 hours at 212° F.

These tests showed somewhat surprising results. The percentage of wear on samples, consisting either of all round or all flat particles, was less after the sodium sulfate treatment than the percentage of wear on similar samples untreated, as indicated below:

	WEAR, PER CENT	
	TREATED	UNTREATED
Round particles	4.8	6.5
Flat particles	18.5	19.5

While sufficient experience has not been had with this method of making the test to permit of an accurate interpretation of the results, it at least indicates that the particles were not materially damaged by the five alternations of sodium sulfate treatment.

Strength Tests.—Both the compression and flexure tests show quite definitely that the flat particles, in the quantities used, had no effect on the strength of the concrete, either in compression or flexure up to 3 months. The results of the strength tests are shown in Table I. The differences in the strengths, sometimes slightly higher for the gravel with flats and sometimes slightly lower, were well within the experimental error which might be expected for tests of the same material.

Slab Surfaces.—Observations of the surface texture of 18 by 18 by 4-in. slabs were made on concrete made with the ¼ to 2¾-in. gravel containing 0 per cent and 15 per cent of flats, using a mix 1:2:3½ by weight. The slabs were finished with a wood float and a strike board and the coarse aggregate was exposed by disintegrating the mortar from the surface to a depth of about ⅜ in. by the application of Surface Bonding Con-Tex, furnished by the Concrete Surface Corp., New York City.

The treated slab surfaces are shown in Figs. 2 and 3. An examination of the surface texture of the slabs shows no great difference in appearance. Brushing the surface of the slab to remove the disintegrated mortar removed about the same amount of coarse aggregate in each case. From the slab containing 15 per cent of flats, 40.6 g. of material coarser than a No. 4 sieve was removed, while from the slab containing 0 per cent of flats, 48.2 g. was removed. The particles removed were smaller than about ⅜ in. In the case of the slab containing 15 per cent of flats, 12.6 g. of the particles removed by the brushing were classified as flat. The Con-Tex provided a very satisfactory method of revealing the aggregate, producing a surface of uniform appearance and depth of disintegration.

CONCLUSIONS

The following are the principal observations which may be made from these test data:

1. Gravel consisting of flat particles showed a higher percentage of wear in the Deval abrasion test than gravel made up of round particles. This can be accounted for to a considerable extent by the impact action of the cast-iron balls added as an abrasive charge.

2. For the conditions of these tests the percentage of wear increased approximately in direct proportion to the percentage of flat particles.

3. For gravel graded from ¼ to 2¾ in. 10 per cent of flat particles caused no decrease in compressive or flexural strength in a 1:2:3½ mix.

4. For gravel graded from ¼ to ¾ in. 14 per cent of flat particles caused no decrease in compressive or flexural strength in a 1:2:2½ mix.

5. Observations of the surface texture of vigorously finished slabs made with ¼ to 2¾ in. gravel, containing 0 and 15 per cent of flat particles, indicate that, in a road slab, the flat particles would not have a tendency to float to the surface or arrange themselves in such a way as to be readily broken out by traffic. These slabs and field observations indicate that there would not be an undue amount of pitting due to flat particles of a sound and durable nature.

APPENDIX III

EFFECT OF COAL AND LIGNITE IN SAND FOR CONCRETE

By P. J. Freeman[1]

A tabulation of 340 tests of local river sands made by Allegheny County Bureau of Tests and Specifications, shown in Table I, shows a marked fall in strength with the initial appearance of color, but, after colors appear, increase in its intensity seems to have little effect on strength.

Table I.—Effect of Color on Strength of Sand for Concrete.

Color Plate	Fineness Modulus	Loam, per-cent by weight	Coal and Lignite, per cent	7-Day Strength Ratio to Ottawa Sand, 2 by 4-in. Cylinders	28-Day Strength Ratio to Ottawa Sand, 2 by 4-in. Cylinders	Number of Tests
No. 0.........	2.84	0.85	0.29	175	168	4
No. 1.........	2.87	0.84	0.55	122	132	31
No. 2.........	2.88	0.97	0.75	126	137	160
No. 3.........	2.83	1.00	0.74	123	138	138
No. 4.........	2.83	1.36	1.48	121	139	7

These results agree quite well with the conclusions of I. F. Morrison and H. R. Webb, as presented in a paper[2] entitled "Effect of Finely Divided Lignite Coal on the Strength of Concrete" presented before the Society in 1924. The conclusions drawn from the results of their investigation are:

> 1. Small amounts of finely divided lignite coal lower the strength of concrete up to periods of one year. The amount of coal for which this effect was observed was only 0.05 per cent, by weight, of sand.
>
> 2. The effect of amounts of this coal greater than 0.05 per cent is not appreciably more than that for 0.05 per cent, up to amounts of 1.0 per cent by weight of sand.
>
> 3. The decrease in strength is about 8 per cent for 0.05 per cent of coal, and is not comparable to the decrease in strength due to the presence of organic acid, as indicated by the colorimetric test.
>
> 4. The colorimetric test cannot be taken as a criterion of inferior quality for sands containing small amounts of lignite coal.

Lignite and decomposed coal produce strong color, with sodium hydrate solutions, but sound coal does not. This accounts for the discrepancy in amounts given in the foregoing table, and those mentioned by Morrison and Webb.

A more specific test for tannins and tannic acid is needed, as a criterion for quality of sands for concrete where lignite or decomposed coal are apt to be present.

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[1] Chief Engineer, Bureau of Tests and Specifications, Department of Public Works, Allegheny County, Pittsburgh, Pa.

[2] See *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part II, p. 841 (1924).

DISCUSSION

Mr. Herbert J. Gilkey[1] (*by letter*).—For years the writer has felt that there exists a great need for some device that will obviate the necessity for an extra operation such as the capping of laboratory or job cylinders and cores. If such a device would at the same time make it unnecessary to use a spherical block to make the plane of the load and the plane of the specimen coincide, so much the better. The writer has performed a great many tests with this in view. Most of these were on 2 by 4-in. mortar cylinders of varying sand-cement and water-cement ratios. For several types of testing ends devised, the variation in strengths between presumably identical specimens were too slight to attribute them to one or another form of testing block. To obtain further information of value would require a very large number of specimens in a very carefully controlled series. Statistical treatment would probably be necessary to draw fair conclusions. The writer has not been in a position to carry the tests to a satisfactory stopping point but it might be helpful to pass along one or two ideas that may be meritorious and partially new.

In some respects the sand cushion resembles any other soft bedment:

1. It flows and introduces a lateral splitting tendency. The corners or outside margin of the specimen are punished and may be spalled off.
2. It packs.
3. The outside can get away and the center cannot. This makes a harder center under the specimen giving something of the undesirable effect of a convex end. There is high local stress, wedging, and splitting. If the hard interior is not perfectly concentric with the specimen, eccentric loading is introduced.
4. The sand pulverizes and the grading becomes finer for each succeeding test.

Recognizing these objections the following attempted remedies have been tried:

1. Confined sand (only slight clearance between specimen and walls of container) probably helped somewhat but did not fully relieve the unsatisfactory corner condition.

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[1] Associate Professor of Civil Engineering, University of Colorado, Boulder, Colo.

2. Testing through a heavy flat plate resting on the sand removed some difficulties and crudely performed the function of the spherical block. If the end of the specimen was not a plane, however, the loading was unequally distributed.

3. Testing through a heavy ring, with outside diameter as large or a little larger than that of the specimen and the inside hole from $\frac{1}{2}$ to 1 in. less than that of the specimen, seemed to help greatly the sand cushion extended under the ring. The corners were saved. The sand cushion was in direct contact with the inner part of the specimen and still there could be no lateral flow or splitting. To have a moderately plane rim on the specimen to fit the ring is a very much simpler matter than to have the end approximate a good plane. Merely rubbing against a brick or a few passes with a rasp or file is sufficient for most specimens and many require no such treatment.

4. To prevent the sand from packing or to stir it up automatically, the container can be made just a little larger than the ring and a sheet of rubber packing placed in the bottom under the sand. As the load is released there is always sufficient rebound to keep the sand loosened. The thickness or number of sheets of rubber may be varied to produce the desired springiness. The edges of the container can also be lined if it seems desirable. Celotex or other springy material can be used instead of the sheet rubber under the sand, or it can be used with the rubber. Celotex has some tendency to pack but retains a degree of resilience better than do many other bedments. There will always be some pulverizing of the sand, especially for strong concretes. It is a question whether this is objectionable if the sand be kept stirred up and is reasonably loose at the beginning of each test.

5. While such a rig removes the need for a spherical bearing block and is very simple to make, it is much easier to use it below the specimen than above it. The normal specimen with one poor end (the top as cast) will therefore be turned upside down for test.

6. An objection to the rig if used under the specimen instead of on top is that the specimen is located between the poor end and the movable head of the testing machine with the result that all adjustments have to be made through the entire specimen. Some additional bending is probably introduced thereby. Just how objectionable this may be is not known. The objection is similar to that of using a spherical segment under the specimen instead of the block on top as called for by the Society's Standard Methods of Making Compression Tests of Concrete (C 39 – 27).[1]

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[1] 1927 Book of A.S.T.M. Standards, Part II. p. 112.

Added work will undoubtedly bring out some very satisfactory form of testing head, plate, or end that will produce good results with a considerable reduction in labor and a minimizing of the personal equation. Whatever is devised should certainly be extended for use in testing tile, brick, etc., since the same problems exist there in even greater degree. The writer hopes to see these matters carried further.

REPORT OF COMMITTEE C-11
ON
GYPSUM

Committee C-11 has held two meetings during the past year, both at the U. S. Bureau of Standards, Washington, D. C., one on October 26, 1928, and the other on March 29, 1929. A third meeting will be held at Atlantic City, N. J., in conjunction with the June, 1929, annual meeting of the Society.

During the past year the committee elected John C. Best (Best Brothers Keene's Cement Co.), Medicine Lodge, Kans., as a producer member.

ACTIVITIES OF SUB-COMMITTEES

Sub-Committee I on Gypsum for Various Uses (F. A. Wilder, chairman).—This sub-committtee has continued the study of the use of gypsum-anhydrite mixtures as a retarder in portland cement. The results of the U. S. Bureau of Mines' investigation have shown that the type of natural anhydrite has very little significance, but the fineness of the retarder is of considerable importance, especially as regards its effect on the plasticity of the cement. Mr. Roller of the New Brunswick station is developing a new type of air analyzer by means of which he will obtain extremely-fine material. He plans to follow up the work of Mr. Berger on the effect of extremely fine anhydrite as a cement retarder.

Sub-Committee II on Gypsum Plasters (J. M. Porter, chairman).—This sub-committee has been particularly active in the review of the specifications for Keene's cement and calcined gypsum for dental plasters. Revisions in these specifications are being recommended as mentioned later in this report. Exhaustive tests to determine various properties of these materials have been conducted by several members of the sub-committee.

Sub-Committee III on Structural Gypsum Products (H. W. Reel, chairman).—The sub-committee has cooperated with the U. S. Bureau of Standards in an extensive series of tests to determine the ultimate stresses in gypsum fiber concrete. The tests have been completed and the results are being incorporated in a technical paper of the Bureau of Standards in course of preparation.

Sub-Committee IV on Testing Methods (H. E. Brookby, chairman).—The U. S. Bureau of Standards conducted a series of tests to determine the relative merit of the modified Vicat apparatus, the Hammond slump tester and the Southard viscosimeter with the result that the modified Vicat apparatus is to be substituted for the Southard viscosimeter for determining normal consistency of calcined gypsum.

RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS

The following recommendations are made to the Society relative to the tentative standards under the jurisdiction of Committee C-11:

Tentative Specifications for Keene's Cement (*C 61 - 28 T*).[1]—Best Brothers Keene's Cement Co., the U. S. Bureau of Standards and the United States Gypsum Co. conducted an extensive series of tests to determine the physical properties of Keene's cement. As a result of these investigations it is recommended that the Tentative Specifications for Keene's Cement (C 61 - 28 T) be revised as follows and continued as tentative:

Section 2.—Change to read as follows by the addition of the italicized word and figure and the omission of those in brackets:

2. Keene's cement shall not set in less than [2 hours] *1 hour* nor more than 4 hours.

Section 8.—Add the following at the end of the first sentence:

except that in the determinations of the time of setting and tensile strength, the consistency used shall be such that a 350-g. modified Vicat needle (Note) shall give a penetration of 15 mm. ±2 mm., 20 seconds after dropping and the measurement being made 20 minutes after the addition of the Keene's cement to the gaging water. Furthermore, in the determination of testing consistency, 0.1 per cent of commercial retarder may be used.

NOTE.—In all essentials except the plunger, the modified Vicat apparatus is the same as the Vicat apparatus described in the Standard Methods of Testing Gypsum and Gypsum Products (A.S.T.M. Designation: C 26). In the modified apparatus, the plunger is made of aluminum tubing. The end that penetrates the mix is $\frac{3}{4}$ in. in diameter and $1\frac{3}{4}$ in. in length, the stem is $\frac{1}{2}$ in. in diameter and $6\frac{1}{2}$ in. in length. The amount of penetration is determined by the drop of the plunger as read on the millimeter scale. The weight of the plunger may be varied by loading with shot.

Tentative Specifications for Calcined Gypsum for Use in the Preparation of Dental Plasters (*C 72 - 28 T*).[2]—Revisions in these specifications are being recommeded in accordance with data developed during a conference with manufacturers of dental plasters. Requirements for an additional grade of calcined gypsum have been added and the addition of a requirement for soaking the calcined gypsum for 30 seconds in distilled water at 70° F. before mixing. It is recommended that the proposed revised specifications, as appended hereto,[1] be accepted for publication as tentative to replace the present Tentative Specifications C 72 – 28 T.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 816 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 232.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 819 (1928); also 1928 Book of A.S.T.M. Standards, p. 235.

Tentative Definitions of Terms Relating to the Gypsum Industry (C 11 – 28 T).[2]—It is recommended that the definitions of the terms "consistency" and "plasticity" be revised as follows, and that the definitions as revised be continued as tentative:

Consistency.—Change from its present form: namely,

> *Consistency*.—The degree of wetness of a plastic mixture.

to read as follows:

> *Consistency*.—A property of a material determined by the complete flow-force relation.

Plasticity.—Change from its present form: namely,

> *Plasticity*.—The yielding property of a wet mixture to change of form.

to read as follows:

> *Plasticity*.—A complex property of a material, involving a combination of the properties of mobility and of yield value.
>
> NOTE.—A plastic material is distinct from a solid material in that it possesses mobility. It is distinct from a fluid material in that it requires a measurable force (yield value) to start flow.

A definition for the term "gypsum partition tile or block" has appeared for the past several years in the Standard Specifications for Gypsum Partition Tile or Block (C 52 – 27). This definition has been reviewed by Committee C-11 in cooperation with Committee E-8 on Nomenclature and Definitions. As a result of this review, the committee suggests the following rewording, which includes as a part of the present definition, Section 2 (*a*) of the Standard Specifications C 52. The present note to the definition is retained as Note 1 and the present Section 2 (*b*) is made Note 2. The complete definition with notes reads as follows:

> ***Gypsum Partition Tile or Block***.—A gypsum building unit in form of tile or block for use in non-bearing construction in the interior of buildings and for the protection of columns, elevator shafts, etc., against fire.
>
> NOTE 1.—The words "tile" and "block" are synonymous and are used so as to be in accord with certain freight association nomenclature.
>
> NOTE 2.—Gypsum cored tile, 3 or 4 in. in thickness, may be split and used for furring purposes.

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[1] See p. 625.—ED.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 821 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 237.

It is recommended that this definition be added to the Tentative Definitions of Terms Relating to the Gypsum Industry (C 11 – 28 T) and the present definition appearing in the Standard Specifications C 52 – 27 be changed accordingly.

One of the functions of Committee C-11 is to prepare specifications covering the various plasters used in the industry. The specifications covering gypsum pottery plaster and gypsum molding plaster are based on data developed by manufacturers of these products. These specifications have been tentative three years and it is now recommended that they be advanced to standard with the following revisions:

Tentative Specifications for Gypsum Pottery Plaster (C 60 – 26 T).[1]

Section 1.—Change to read as follows by the omission of the words in brackets:

> 1. Gypsum pottery plaster is a material consisting essentially of calcined gypsum for use in making pottery [terra cotta and other ceramic] molds.

Section 9(a).—Add "100-lb. paper sacks" before the reference to "80-lb. paper sacks."

Tentative Specifications for Gypsum Molding Plaster (C 59 – 26 T).[1]

Section 9(a).—Add "100-lb. paper sacks" before the reference to "80-lb. paper sacks."

The recommendations appearing in this report have been submitted to letter ballot of the committee with the following results:

Items	Affirmative	Negative	Not Voting
I. PROPOSED REVISIONS OF TENTATIVE STANDARDS			
1. Tentative Specifications for Keene's Cement (C 61 – 28 T)	23	1	3
2. Tentative Specifications for Calcined Gypsum for Use in the Preparation of Dental Plasters (C 72 – 28 T)	21	0	6
3. Tentative Definitions of Terms Relating to the Gypsum Industry (C 11 – 28 T):			
Consistency	23	1	3
Plasticity	23	1	3
Gypsum Partition Tile or Block	24	0	3
II. ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
4. Tentative Specifications for Gypsum Molding Plaster (C 59 – 26 T)	22	0	5
5. Tentative Specifications for Gypsum Pottery Plaster (C 60 – 26 T)	22	0	5

This report has been submitted to letter ballot of the committee, which consists of 32 members; 27 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

J. W. GINDER,
Chairman.

H. J. SCHWEIM,
Secretary.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, pp. 747, 745 (1926); also 1928 Book of A.S.T.M. Tentative Standards, pp. 230, 228.

EDITORIAL NOTE

The proposed revisions of the Tentative Specifications for Keene's Cement, and for Calcined Gypsum for Use in the Preparation of Dental Plasters were accepted. The tentative specifications in their revised form appear on pages 622 and 625, respectively.

The proposed revisions of the definitions for consistency and plasticity appearing in the Tentative Definitions of Terms Relating to the Gypsum Industry were accepted. The definitions in their revised form appear on page 627. The proposed rewording of the definition for gypsum partition tile or block appearing in the Standard Specifications for Gypsum Partition Tile or Block was accepted. The definition in its revised form appears in the Tentative Definitions of Terms Relating to the Gypsum Industry on page 627.

The Tentative Specifications for Gypsum Molding Plaster, and for Gypsum Pottery Plaster were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 129 and 131, respectively.

REPORT OF COMMITTEE D-1

ON

PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS

Committee D-1 on Preservative Coatings for Structural Materials held a meeting at the Society's headquarters, Philadelphia, on March 28, 1929. Since the last annual meeting, three resignations have been accepted while nine new members have been elected, making a total of 186.

The past year has been an exceptionally active one for the committee and much new material is being submitted to the Society for its approval. The activities of the various sub-committees are presented in detail in this report or in their appended reports. In consequence of the work which has been done, the committee is making the following recommendations:

I. Three new tentative methods of test and four new tentative specifications are being submitted;

II. Revision of four standards is being proposed;

III. The revision of two tentative standards is recommended;

IV. Four tentative methods are being recommended for advancement to standard;

V. Tentative revision of one existing standard is recommended for advancement to standard;

VI. Three tentative standards are recommended to be withdrawn.

RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS

The recommendations affecting standards and tentative standards are presented first in summarized form, together with an analysis of the letter ballot on each item. They are referred to in greater detail in reporting the activities of the sub-committees directly responsible for them.

I. Proposed Tentative Standards.—The committee submits for publication as tentative the following four new specifications[1] and three new methods of test[2] as appended hereto:

Proposed Specifications for Soluble Nitrocellulose, recommended by Sub-Committee XXV;

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[1] See pp. 639 to 651, inclusive.—Ed.

[2] See pp. 675 to 686, inclusive.—Ed.

Proposed Specifications for Ethyl Acetate (85 to 88 per cent Grade), recommended by Sub-Committee XXV;

Proposed Specifications for Butyl Acetate (85 to 88 per cent Grade), recommended by Sub-Committee XXV;

Proposed Specifications for Butanol (Normal Butyl Alcohol), recommended by Sub-Committee XXV;

Proposed Method of Routine Determination of Acetone Extract in Dry Lampblack and Dry Bone Black, recommended by Sub-Committee VIII;

Proposed Method of Test for Determination of Polishing Lubricant in Aluminum Powder for Paints (Aluminum Bronze Powder), recommended by Sub-Committee VIII;

Proposed Method of Analysis for the Color Characteristics of Paints in Terms of Fundamental Physical Units, recommended by Sub-Committee XVIII.

II. *Proposed Revision of Standards.*—As recommended by Sub-Committee XIII the committee recommends that the Proposed Methods of Sampling and Testing Shellac, as appended hereto,[1] be accepted for publication as tentative to replace when adopted the Standard Methods of Testing Shellac (D 29 – 25) and Methods for Determination of Wax in Shellac (D 29 – 28) and also the Tentative Methods of Testing Shellac Varnish (D 214 – 27 T), the latter methods to be discontinued.

Also, as recommended by Sub-Committee XIII, the committee recommends that the proposed revision of the Standard Specifications for Dry Bleached Shellac (D 207 – 26) and for Orange Shellac (D 237 – 27) in the form of separate proposed tentative specifications, as appended hereto,[2] be accepted for publication as tentative.[3]

The committee also recommends that the revision of the Standard Methods of Routine Analysis of Dry Red Lead (D 49 – 28), recommended by Sub-Committee VIII, be accepted and referred to letter ballot of the Society for immediate adoption as standard. The committee accordingly asks for the necessary nine-tenths vote.

III. *Proposed Revisions of Tentative Standards.*—The committee recommends that the proposed revisions of the following two tentative methods, as given in detail in the reports of the sub-committees be accepted, and the methods, as revised, be continued as tentative:

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[1] See p. 655.—ED.

[2] See pp. 637 and 638, respectively.—ED.

[3] This recommendation differs from that which appeared in the report as preprinted, see Summary of Proceedings, p. 29.—ED.

Methods of Test for Bleeding of Pigments (D 279 – 28 T), recommended by Sub-Committee VIII;

Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 – 27 T), recommended by Sub-Committee XXV.

IV. *Tentative Standards Advanced to Standard.*—The committee recommends that the following four tentative standards be advanced to standard:

Methods of Test for Coarse Particles in Dry Pigments and Coarse Particles and Skins in Mixtures of Pigments and Vehicles (D 185 – 28 T), as recommended by Sub-Committee VIII to supersede the present Standard Method D 185 – 26;

Methods of Routine Analysis of White Linseed Oil Paints (D 215 – 28 T), revised as recommended by Sub-Committee VIII;

Method of Routine Analysis of Dry Cuprous Oxide (D 283 – 28 T), recommended by Sub-Committee VIII;

Method of Routine Analysis of Dry Mercuric Oxide (D 284–28 T), recommended by Sub-Committee VIII.

V. *Advancement to Standard of Tentative Revisions of Standards.*—The committee recommends the adoption as standard of the tentative revision of the Standard Methods of Routine Analysis of Titanium Pigments (D 186 – 27), recommended by Sub-Committee VIII.

VI. *Withdrawal of Tentative Standards.*—The committee recommends that the following three tentative standards be withdrawn:

Specifications for Titanium Barium Pigment (D 265 – 27 T), as recommended by Sub-Committee XV;[1]

Methods of Test for Mass Color and Tinting Strength of Pigments (D 282 – 28 T), recommended by Sub-Committee VIII;

Methods of Testing Shellac Varnish (D 214 – 27 T), recommended by Sub-Committee XIII.

The above recommendations have been submitted to letter ballot of the committee, which consists of 186 members; 29 members returned their ballots. The analysis of the vote of the committee is given in the accompanying Table I.

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[1] The recommendation to discontinue this specification differs from that which appeared in the report as preprinted, see Summary of Proceedings, p. 30.

ACTIVITIES OF SUB-COMMITTEES

Appended are reports of the following sub-committees:

Sub-Committee VII on Accelerated Tests for Protective Coatings;

Sub-Committee VIII on Methods of Analysis of Paint Materials.

In addition to the sub-committee reports appended, the activities of the other sub-committees are presented as follows:

Sub-Committee III on Testing of Paint Vehicles (H. A. Gardner, chairman).—This sub-committee recommends that the Tentative Specifications for Raw Tung Oil (D 12 – 25 T) be continued as tentative pending further development of raw tung oil production in America, which is progressing rapidly.

TABLE I.—ANALYSIS OF LETTER BALLOT VOTE

Items	Affirmative	Negative	Not Voting
I. TENTATIVE STANDARDS			
Proposed Specifications for Soluble Nitrocellulose	17	0	12
Proposed Specifications for Ethyl Acetate	17	0	12
Proposed Specifications for Butyl Acetate	17	0	12
Proposed Specifications for Butanol	17	0	12
Proposed Method of Routine Determination of Acetone Extract in Dry Lampblack and Dry Bone Black	21	1	7
Proposed Method of Test for Determination of Polishing Lubricant in Aluminum Powder for Paints	24	0	5
Proposed Method of Analysis for the Color Characteristics of Paints in Terms of Fundamental Physical Units	50[a]	1[a]	13[a]
II. PROPOSED REVISIONS OF EXISTING STANDARDS			
Specifications for Dry Bleached Shellac (D 207 – 26)	48[a]	1[a]	15[a]
Specifications for Orange Shellac (D 237 – 27)	44[a]	1[a]	19[a]
Methods of Testing Shellac (D 29 – 25)	48[a]	0[a]	16[a]
Methods of Routine Analysis of Dry Red Lead (D 49 – 28), immediate adoption	24	0	5
III. PROPOSED REVISIONS OF TENTATIVE STANDARDS			
Methods of Test for Bleeding of Pigments (D 279 – 28 T)	23	0	6
Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 – 27 T)	19	0	10
IV. ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
Methods of Test for Coarse Particles in Dry Pigments and Coarse Particles and Skins in Mixtures of Pigments and Vehicles (D 185 – 28 T)	23	0	6
Methods of Routine Analysis of White Linseed Oil Paints, as revised (D 215 – 28 T)	23	0	6
Method of Routine Analysis of Dry Cuprous Oxide (D 283 – 28 T)	23	0	6
Method of Routine Analysis of Dry Mercuric Oxide (D 284 – 28 T)	23	0	6
V. ADVANCEMENT TO STANDARD OF TENTATIVE REVISIONS OF EXISTING STANDARDS			
Methods of Routine Analysis of Titanium Pigments (D 186 – 27)	24	0	5
VI. WITHDRAWAL OF TENTATIVE STANDARDS			
Specifications for Titanium Barium Pigment (D 265 – 27 T)	46[a]	0[a]	18[a]
Methods of Test for Mass Color and Tinting Strength of Pigments (D 282 – 28 T)	22	0	7
Methods of Testing Shellac Varnish (D 214 – 27 T)	19	0	10

[a] These are the results of the subsequent letter ballot on changes made at the annual meeting in the committee's original recommendations as given in the preprinted copy of the report, see Summary of Proceedings, pp. 27 to 31.

Sub-Committee VI on Definitions (D. W. Edgerly, chairman).—This sub-committee is making considerable progress in a study of present definitions, particularly in comparing them with definitions proposed by other committees and by other technical societies.

Sub-Committee XIII on Shellac (J. W. Paisley, chairman).—This sub-committee has completely rewritten the several specifications and methods of testing shellac and shellac varnishes, consisting in a separation of the methods of test from the specifications, and combining under one title in a more logical manner the test procedures that are described at the present time in the specifications and in the several different methods. The sub-committee therefore recommends for publication as tentative the Proposed Methods of Sampling and Testing Shellac, as appended hereto,[1] as a complete rewriting of the several procedures for testing shellac now appearing in the Standard Methods of Testing Shellac (D 29 – 25)[2], Test for Determination of Wax in Shellac ("Machine-Made" and Dry-Bleached Refined Shellac) (D 29 – 28)[3], the Tentative Methods of Testing Shellac Varnish (D 214 – 27 T)[4]; and the Specifications for Dry Bleached Shellac (D 207 – 26)[2] and Orange Shellac (D 237 – 27).[2]

The sub-committee also recommends that the specifications for dry bleached and orange shellac, as appended hereto,[5] be accepted for publication as tentative as a revision of the Standard Specifications for Dry Bleached Shellac (D 207 – 26) and for Orange Shellac (D 237 – 27).[6] The sub-committee is considering a change in the Note in Specifications D 237 and expects to make a recommendation in this regard before the specifications are accepted at the annual meeting.[7]

Sub-Committee XIV on the Preparation of Iron and Steel Surfaces for Painting (A. W. Carpenter, chairman).—The sub-committee is continuing its exposure tests of painted steel panels and will make another inspection this year.

Sub-Committee XV on Specifications for Pigments Dry and in Oil when Marketed in that Form (H. E. Smith, chairman).—This sub-committee recommends that the Tentative Specifications for Titanium Barium Pigment (D 265 – 27 T)[8] be discontinued.[9]

The sub-committee has given further consideration to the tentative specifications for pigments which are under its jurisdiction and it believes that more experience with them is desirable and accordingly recommends the continuation as tentative of the Tentative Specifications for Aluminum Powder for Paints (Aluminum Bronze Powder) (D 266 - 28 T) and the Tentative Specifications for Gold Bronze Powder (D 267 - 28 T).

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[1] See p. 655.—Ed.

[2] 1927 Book of A.S.T.M. Standards, Part II.

[3] 1928 Supplement to Book of A.S.T.M. Standards, p. 117.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 862 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 342.

[5] See pp. 637 and 638, respectively.—Ed.

[6] This recommendation differs from that which appeared in the report as preprinted, see Summary of Proceedings, p. 29.—Ed.

[7] See Summary of Proceedings, p. 29.—Ed.

[8] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 858 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 322.

[9] This recommendation differs from that which appeared in the report as preprinted, see Summary of Proceedings, p. 30.—Ed.

The sub-committee has considered a proposal to revise the Standard Specifications for Lithopone (D 208 - 26) by increasing the minimum zinc sulfide content from 26 to 28 per cent. Since lithopones of good quality so rarely analyze over 28 per cent this limit might result in unreasonable rejections and the committee accordingly considered the change inadvisable.

The sub-committee has before it for future work the formulation of specifications for putty.

Sub-Committee XVIII on Physical Properties of Paint Materials (F. P. Ingalls, chairman).—This sub-committee has completed most of the work on color of paint, reported in detail in 1926,[1] and recommends for publication as tentative the Proposed Method of Analysis for the Color Characteristics of Paints in Terms of Fundamental Physical Units appended hereto.[2]

Sub-Committee XXIII on Anti-Fouling Paints (A. M. Muckenfuss, chairman).—The sub-committee understands that the Tentative Specifications for Toxic Ingredients in Anti-Fouling Paints (D 277 - 28 T) are being received satisfactorily and recommends that they be continued as tentative for another year. The sub-committee now proposes to study the problem of the function of the first or so-called "anti-corrosive coat" in ship-bottom paints, and sees its way clear toward starting a series of tests along this line in the near future.

Sub-Committee XXV on Cellulose Ester Coatings (J. B. Wiesel, chairman).—This sub-committee recommends for publication as tentative, as appended hereto, Proposed Specifications for Soluble Nitrocellulose,[3] and three proposed specifications for solvents,[4] namely, Specifications for Ethyl Acetate (85 to 88 per cent Grade), for Butyl Acetate (85 to 88 per cent Grade), and for Butanol (Normal Butyl Alcohol).

This sub-committee also recommends that the Tentative Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 - 27 T)[5] be revised as follows and continued as tentative:

Section 3.—Omit the first sentence, reading as follows:

Specific gravity shall be determined for all solvents and diluents.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 347 (1926).

[2] See p. 678.—ED.

[3] See p. 639.

[4] See pp. 649 to 651, inclusive.—ED.

[5] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 870 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 349.

Section 4.—Omit the first sentence, reading as follows:

Color shall be determined for all solvents and diluents.

Section 5.—Change from its present form: namely,

5. The distillation test shall be conducted on all solvents and diluents, in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (Serial Designation: D 86) of the American Society for Testing Materials, except that the observations made shall be not of volumes of distillate coming over at certain specified temperatures, but of the temperatures at which certain specified volumes of the distillate come over. The temperature shall be observed and recorded at first drop of the distillate, and when the volume of the distillate collected, observed to the nearest 0.5 cc., reaches 5 cc., 10 cc., 20 cc., 30 cc., 40 cc., 50 cc., 60 cc., 70 cc., 80 cc., 90 cc., 95 cc., and end point.

to read as follows:

5. The distillation test shall be conducted in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials, except that all observations of volumes of distillate shall be read at the temperature specified for the individual solvent or diluent under test.

Section 6.—Omit the first sentence, reading as follows:

The residue shall be determined for all solvents and diluents.

Section 9.—Omit the first sentence, reading as follows:

Water shall be determined for all solvents and diluents.

Section 10.—Omit the first sentence, reading as follows:

Acidity shall be determined for all solvents and diluents.

Section 12.—Change the first three sentences from their present form: namely,

12. Ester value shall be determined for all esters. One to two grams of the sample shall be weighed in an ampoule, by first weighing the empty ampoule, warming and filling, and then sealing-off and reweighing. The ampoule shall be placed in a 200-cc. Erlenmeyer flask which contains 50 cc. of approximately 0.5 N alcoholic KOH.

to read as follows:

12. One to two grams of the sample shall be weighed in an ampoule, by first weighing the empty ampoule, warming and filling, and then sealing-off and reweighing. The ampoule shall be placed in a 200-cc. Erlenmeyer flask which contains approximately one and one-half times the theoretical quantity of 0.5 N KOH required for complete saponification.

The Group on Solvents, Diluents and Plasticizers is continuing its work on individual solvents and plasticizers.

It is hoped that certain portions of the work of the Groups on

Resins and on Finished Lacquers will have progressed far enough for the presentation of proposed specifications at the June meeting.

This report has been submitted to letter ballot of the committee, which consists of 186 members; 29 members returned their ballots, of whom 25 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

ALLEN ROGERS,
Chairman.

R. L. HALLETT,
Secretary.

EDITORIAL NOTE

The proposed Tentative Specifications for Soluble Nitrocellulose, Ethyl Acetate (85 to 88 per cent Grade), Butyl Acetate (85 to 88 per cent Grade), and Butanol (Normal Butyl Alcohol) were accepted for publication as tentative and appear on pages 639, 649, 650 and 651 respectively.

The proposed Method of Routine Determination of Acetone Extract in Dry Lampblack and Dry Bone Black and Method of Test for Determination of Polishing Lubricant in Aluminum Powder for Paints (Aluminum Bronze Powder) were accepted for publication as tentative and appear on pages 675 and 676, respectively. The proposed Tentative Method of Analysis for the Color Characteristics of Paints in Terms of Fundamental Physical Units, as revised on the floor of the annual meeting, see Summary of Proceedings, page 27, were accepted for publication as tentative and appear on page 678.

The proposed revisions of the Standard Specifications for Orange Shellac and the Standard Methods of Testing Shellac in the form of separate tentative standards, were accepted for publication as tentative as revised on the floor of the annual meeting, see Summary of Proceedings, page 29, and appear on pages 638 and 655, respectively. The proposed revision of the Standard Specifications for Dry Bleached Shellac in the form of separate tentative specifications was accepted for publication as tentative and appears on page 637.

The proposed revision of the Standard Methods of Routine Analysis of Dry Red Lead was approved at the annual meeting by a nine-tenths vote and was subsequently adopted by letter ballot of the Society on September 3, 1929. The standard methods, in their revised form, appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 172.

The proposed revisions of the Tentative Method of Test for Bleeding of Pigments, and Methods of Sampling and Testing Lacquer Solvents and Diluents were accepted. The tentative methods in their revised form appear on pages 652 and 672, respectively.

The Tentative Methods of Test for Coarse Particles in Dry Pigments and Coarse Particles and Skins in Mixtures of Pigments and Vehicles to supersede the present standard method, Routine Analysis of White Linseed Oil Paints, Routine Analysis of Dry Cuprous Oxide, and Routine Analysis of Dry Mercuric Oxide were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 169, 184, 206 and 208, respectively.

The tentative revision of the Methods of Routine Analysis of Titanium Pigments was approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929. The revised standard specifications appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 178.

The withdrawal of the Tentative Specifications for Titanium Barium Pigments, Methods of Test for Mass Color and Tinting Strength of Pigments, and Methods of Testing Shellac Varnish was approved.

REPORT OF SUB-COMMITTEE VII ON ACCELERATED TESTS FOR PROTECTIVE COATINGS

Sub-Committee VII held two meetings during the past year. The individual activities of the members have continued with considerable expansion. One cooperative program has been carried through to a successful conclusion.

It is still the feeling of the sub-committee that the time has not yet arrived for inaugurating extensive cooperative tests for the purpose of comparing the various testing systems that have been developed up to the present time. It is believed that time might better be spent by the individual laboratories in checking their own tests against results of outdoor weathering tests, and that any attempt made to discriminate between them will tend to discourage the individual research that is so badly needed.

A standardized form for recording and reporting results was agreed upon and adopted tentatively for the use of the sub-committee. It is hoped that experience with its use may finally develop something worth while recommending for general adoption.

The main problem before the sub-committee during the year has been to determine the magnification most suitable for examining and photographing failures of protective coatings. At present, microscopic practice varies greatly among different laboratories. Before any progress can be made in comparing tests, or testing methods, exposure panels must be examined under comparable conditions. For example, two operators examining panels at magnifications of 5 and 75, respectively, will arrive at wholly different conclusions as to when first failure has appeared on a panel. The problem has been to select that magnification which will enable the observer to detect and properly evaluate the various defects as they appear. After a series of tests involving examining and photographing panels at various magnifications, the sub-committee came to the conclusion that for practical purposes, a reasonably low magnification will yield relatively more information concerning the true state of the film than will a higher magnification. This magnification must be sufficiently high to catch failures when they have attained a really significant stage of development but not so high as to give undue prominence to the appearance of irregularities that may have no practical significance in terms of service. In view of this the sub-committee recommends the following:

1. Visual microscopic examination and photomicrographs should be made at magnifications not exceeding ten diameters.

2. If photomicrographs originally taken at lower magnifications are subsequently enlarged, this fact should be indicated by the following nomenclature appearing with the photomicrograph: Magnification ...., Enlargement .....

It has further been decided that the sub-committee will correlate the individual reports on which the above recommendations are based and, if it is at all feasible to do so, present the data before a general meeting of the Society.

The next steps in the work of the sub-committee have been the subject of considerable discussion. It is very apparent that the sub-committee will have to consider itself essentially a research committee for some time to come, its main function being to foster and stimulate individual research on its problems. A wide variety of problems has been suggested, as for example:

1. Quantitative methods for determining when protective coatings have failed.

2. Fundamental nature and cause of failures such as checking and cracking, with especial reference to the means essential for reproducing typical results in accelerated weathering tests. The underlying causes of chalking failures, for example, are now pretty well understood, but this is not the case with other types of failures.

3. To what extent is refrigeration a necessary adjunct of an accelerated weathering system?

4. Is it feasible to specify standard wood panels that will eliminate the variables ordinarily introduced by the differences in woods that normally appear from season to season? Interesting results have already been obtained by one member of the sub-committee with a laminated ply-wood panel. The cooperation of the U. S. Forest Products Laboratory would be sought in working on this problem. Conversely, can a wood that is normally difficult to paint be sufficiently standardized so that standard panels can be selected for testing protective coatings under adverse painting conditions?

The sub-committee realizes that many other important problems of this nature deserve attention and it welcomes suggestions.

Respectfully submitted on behalf of the sub-committee,

H. A. NELSON,
Chairman.

REPORT OF SUB-COMMITTEE VIII ON METHODS OF ANALYSIS OF PAINT MATERIALS

This sub-committee is recommending, as appended hereto,[1] a new proposed Tentative Method of Routine Determination of Polishing Lubricant in Aluminum Powder for Paint (Aluminum Bronze Powder). This method was developed as the result of a request for a method of determining polishing lubricant, requirement for which is specified in the Tentative Specifications for Aluminum Powder for Paints (Aluminum Bronze Powder) (D 266 – 28 T). This method has been tested out in the laboratories of the U. S. Bureau of Standards.

This sub-committee is also recommending, as appended hereto,[2] a new proposed Tentative Method of Routine Determination of Acetone Extract in Dry Lampblack and Dry Bone Black. This method was developed as the result of a request for a method of determining the percentage of extract, requirements for which are specified in the Standard Specifications for Lampblack (D 209 – 26) and for Bone Black (D 210 – 26). The method was developed and tested out in the laboratories of the Bureau of Standards in connection with the formulation of Federal Specifications Board specifications for these pigments.

This sub-committee in cooperation with the editorial committee of Committee E-1 on Methods of Testing has reviewed the test for water-soluble matter and recommends that the Standard Methods of Routine Analysis of Dry Red Lead (D 49 – 28)[3] be revised as follows, and that the methods, as revised, be continued as standard. The committee accordingly asks for the necessary nine-tenths vote for immediate adoption.

Section 8.—It is recommended that this section be changed from its present form: namely,

> 8. Digest 10 g. of sample with 200 cc. of hot water on steam bath for 1 hour; filter on an 11-cm. S. & S. blue-ribbon paper and wash with hot water till no residue is left on evaporating a few drops of the washings. Evaporate filtrate to dryness on steam bath in a weighed dish, dry 30 minutes at 105° C., cool and weigh. Take up with water and if alkaline, titrate with tenth normal acid and methyl orange; calculate to Na_2CO_3.
>
> Another lot of water-soluble matter is tested for nitrates, nitrites, carbonates, sulfates, sodium and lead.

to read as follows:

8. Transfer 25.0 g. of the pigment to a graduated 250-cc. flask, add 100 cc.

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[1] See p. 676.—Ed.

[2] See p. 675.—Ed.

[3] 1928 Supplement to **Book of** A.S.T.M. Standards, p. 124.

of water and boil for five minutes. Cool to room temperature, dilute to the mark with water, mix, and allow to settle. Filter the supernatant liquid through a dry filter paper and discard the first 20 cc. of the filtrate. Transfer 100 cc. of the clear filtrate to a weighed dish, evaporate to dryness on a steam bath, dry for one hour in an oven at 105 to 110° C.; cool and weigh. Calculate the percentage of water-soluble matter.

No criticisms having been received, the sub-committee recommends that the Tentative Methods of Test for Coarse Particles in Dry Pigments and Coarse Particles and Skins in Mixtures of Pigments and Vehicles (D 185 – 28 T)[1] issued last year as a revision of the Standard Method of Test for Coarse Particles in Paint Pigments (D 185 – 26)[2] be adopted as standard. The sub-committee accordingly recommends that the Standard Methods D 185 – 26 be withdrawn.

The sub-committee recommends that the tentative revisions of the Standard Methods of Routine Analysis of Titanium Pigments (D 186 – 27) recommended in 1928[3] be adopted as standard.

No criticisms having been received, the sub-committee also recommends that the following tentative standards, with revisions of one as indicated below, be advanced to standard:

Tentative Methods of Routine Analysis of White Linseed Oil Paints (D 215 – 28 T).[4]—In the section on Testing Non-Volatile Vehicle, under (*a*) Preparation of Fatty Acids, add an additional paragraph, to appear as the second paragraph, to read as follows:

The above method of preparing the fatty acids directly from the material, rather than from the extracted vehicle, is based upon past experience in sometimes obtaining too low results by the latter method. Occasionally, however, trouble is experienced in saponifying the entire material, due to interference of pigment. In such an instance it is permissible to save the extracted vehicle (see Section on Percentage of Pigment), evaporate the organic solvents on a steam bath, and saponify and prepare the fatty acids in the usual manner from this extract. If the iodine number obtained in this manner passes a given specification, no further work is necessary. If the iodine number is low, it will be necessary to repeat the work directly on the entire material.

Tentative Method of Routine Analysis of Dry Cuprous Oxide (D 283 – 28 T),[5] without revision.

Tentative Method of Routine Analysis of Dry Mercuric Oxide (D 284 – 28 T),[5] without revision.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 874 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 328.

[2] 1927 Book of A.S T.M. Standards, Part II, p. 286.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1127 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 859.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 888 (1928); also 1928 Book ofA.S.T.M Tentative Standards, p. 352.

[5] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, pp. 910, 912 (1928); also 1928 Book of A.S.T.M. Tentative Standards, pp. 374, 376.

The sub-committee further recommends that the following tentative standard be revised as indicated below and continued as tentative:

Tentative Methods of Test for Bleeding of Pigments (D 279 - 28 T).[1]

Section 1.—In the second and fifth sentences, after the word "lacquer" add the phrase "of a composition mutually agreed upon by the buyer and seller."

The committee recommends that the following tentative methods be continued as tentative without revision:

Tentative Method of Test for Alkalinity or Acidity of Pigments (D 278 - 28 T)[1];

Tentative Methods of Test for Hygroscopic Moisture (and Other Matter Volatile Under the Test Conditions) in Pigments (D 280 - 28 T)[1];

Tentative Method of Test for Oil Absorption of Pigments (D 281 - 28 T).[1]

The sub-committee recommends that the following tentative methods be withdrawn:

Tentative Methods of Test for Mass Color and Tinting Strength of Pigments (D 282 - 28 T).[1]

Respectfully submitted on behalf of the sub-committee,

F. W. SMITHER,
Chairman.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, pp. 877-887 (1928); also 1928 Book of A.S.T.M. Tentative Standards, pp. 331-341.

REPORT OF COMMITTEE D-2

ON

PETROLEUM PRODUCTS AND LUBRICANTS

Committee D-2 on Petroleum Products and Lubricants has held three regular meetings during the past year (in June at Atlantic City, in January at Baltimore, and in March at New York City) and also an informal meeting in December at Chicago, at the time of the annual meeting of the American Petroleum Institute.

One new sub-committee, XXVII on Transmission Lubricants Classification, was formed during the year.

Sub-Committees II on Gas Absorbent Oil and XXVII on Application of Tests were discontinued, and the Special Sub-Committee on Specific Gravity and new Sub-Committee on Lubricants Classification were given the designations of Sub-Committees II and XXVII, respectively.

The voting membership of this committee now consists of 40 producer, 27 consumer and 14 general interest members.

Acting as the Sectional Committee on Methods of Testing Petroleum Products and Lubricants functioning under the American Standards Association, the following three standard methods of test were submitted to the A.S.A. for approval as American Standards. The methods have since been approved as American Standard by the A.S.A. with the A.S.A Numbers indicated below·

Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 – 28) (A.S.A. No. Z 11*i* – 1928);

Method of Test for Water and Sediment in Petroleum Products by Means of Centrifuge (D 96 – 28) (A.S.A. No. Z 11*h* – 1928);

Method of Test for Steam Emulsion of Lubricating Oils (D 157 – 28) (A.S.A. No. Z 11*o* – 1928).

Consideration has also been given to other A.S.T.M. Standards for Petroleum Products for approval by the American Standards Association. It was agreed to make the following recommendations after submission to letter ballot of the committee:

(1) That the A.S.T.M. Method of Test for Saponification Number (D 94 – 28) be approved as an American Standard, and

(2) That the A.S.T.M. Tentative Method of Test for Detection of Free Sulfur and Corrosive Sulfur Compounds in Gasoline (D 130 – 27 T) be approved as an American Tentative Standard.

NEW TENTATIVE METHOD

The committee is presenting for approval for publication as tentative, the proposed Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes, submitted by Sub-Committee III on Paraffin Wax and appended hereto.[1]

RECOMMENDED REVISIONS OF TENTATIVE METHODS

The committee recommends revisions of the following methods of test and, upon approval of these revisions, that the methods be continued as tentative.

1. *Tentative Method of Test for Sulfur in Naphthas and Illuminating Oils* (D 90 - 26 T).[2]—The method as rewritten and appended hereto[3] is recommended by Sub-Committee VII on Sulfur Determination and Differentiation. The purpose of this extensive revision is to specify the apparatus and the procedure more closely in order that more uniform and more accurate results may be obtained. The title has been changed to "Tentative Method of Test for Sulfur in Motor Fuels, Naphthas and Illuminating Oils (Lamp Method)."

2. *Tentative Method of Test for Precipitation Number of Lubricating Oils (D 91 - 21 T).*[4]—The following changes are recommended by Sub-Committee IX on Precipitation:

Section 2.—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

> 2. A.S.T.M. Precipitation Number of Lubricating Oils.—The number of cubic centimeters of precipitate formed when 10 cc. of lubricating oil are mixed with 90 cc. of petroleum naphtha [of definite quality] *as specified in Section 5* and centrifuged under [definite] prescribed conditions.

Section 4.—Change the tabulation regarding calibration of centrifuge tubes by the addition of a new first line of figures and changing the present first line by the addition of the italicized figures and the omission of the figure in brackets, as follows:

RANGE	SCALE DIVISION	LIMIT OF ERROR	NUMBERED, CC.
0 - 0.5 cc.	*0.05 cc.*	*0.02 cc.*	$\frac{1}{2}$ *cc.*
[0] *0.5* - 3 "	0.1 "	0.05 "	1, 2, 3 "

Section 5.—Change Paragraph (*a*) from its present form: namely,

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[1] See p. 682.—Ed.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 848 (1926); also 1928 Book of A.S.T.M Tentative Standards, p. 443.

[3] See p. 697.—Ed.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 21, p. 648 (1921); also 1928 Book of A.S.T.M. Tentative Standards, p. 440.

(*a*) Petroleum naphtha meeting the following requirements shall be used for the diluent:

Specific gravity at 60° F. . . . . .0.695 – 0.705
Initial Boiling Point, A.S.T.M. . . . . .113 – 131° F. (45° – 55° C.)
End Point, A.S.T.M. . . . . .not higher than 248° F. (120° C.)

to read as follows:

(*a*) Petroleum naphtha conforming to the following requirements shall be used for the diluent:

Gravity, deg. A.P.I. at 60° F. . . .70 to 73
Aniline Point, deg. Centigrade. . .58 to 60
Initial Boiling Point, A.S.T.M. . .not less than 122° F. (50° C.)
50-per-cent point, A.S.T.M. . . . . .158 to 176° F. (70 to 80° C.)
End Point, A.S.T.M. . . . . .not more than 266° F. (130° C.)

Change Paragraph (*b*) to read as follows by the addition of the italicized words:

(*b*) The initial boiling point, ***the 50-per-cent point***, and the end point of petroleum naphtha shall be determined in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials.

Add a new Paragraph (*c*) reading as follows:

(*c*) The aniline point of the petroleum naphtha shall be determined as follows: Measure 10 cc. of the sample and 10 cc. of the aniline (freshly distilled, free from aminothiophenes) into a large test tube fitted with a stirrer and a thermometer. Heat the mixture by means of a naked flame until it becomes homogeneous, and then allow to cool until it becomes turbid. Raise the temperature slightly and make a duplicate determination. Disregard any slight initial turbidity, taking the temperature when the solution becomes completely cloudy. If the aniline point is more than 10° C. above the room temperature, use another larger test tube to form an air jacket.

Section 7.—Change the last sentence to read as follows by the addition of the italicized words:

In general, not more than four whirlings are required *for oils having a low Precipitation Number.*

3. *Tentative Method of Test for Distillation of Crude Petroleum (D 285 – 28 T).*[1]—The committee also recommends, subject to confirmation by letter ballot,[2] that this method be revised to provide that the angle of the vapor tube of the distillation flask and of the condenser tube be 75 deg. rather than 80 deg. to the vertical. This change is important at this time to bring the condenser into conformity with that prescribed in the Standard Method of Test for Distillation of

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 917 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 415.

[2] See Editorial Note, p. 358.

Gasoline, Naphtha, Kerosine and Similar Petroleum Products (D 86 - 27) thus avoiding the necessity of constructing special condensers for this method. It involves a change in three places in the method as follows:

Section 2.—In the last sentence change the angle that the vapor tube makes with the Hempel flask from 80 deg. to read 75 deg.

Figure 1.—Change the angle which the vapor tube makes with the Hempel flask from 80 deg. to 75 deg.

Section 5.—In the second sentence change 80 deg. to read 75 deg.

PROPOSED TENTATIVE REVISION OF STANDARD METHODS

The committee recommends for publication as tentative the following revisions of standard methods:

1. *Standard Method of Test for Viscosity of Petroleum Products and Lubricants (D 88 - 26).*[1]—The following changes are recommended by Sub-Committee V on Viscosity (W. H. Herschel, chairman) to provide for the use of the instrument at three temperatures:

Section 1 (c).—Add a new sentence to this paragraph, to read as follows:

> The Saybolt Furol Viscosimeter shall not be used for times of flow less than 25 seconds.

Section 3.—Change Paragraph (*b*) to read as follows by the addition of the italicized figures:

> (*b*) With the Saybolt Furol Viscosimeter, determinations shall be made at *77*, 122 *or 212°* F. (*25*, 50 *or 100°* C.).

Omit Paragraph (*d*) of this section, reading as follows:

> (*d*) Fuel oils and other oils of similar viscosity showing a time of less than 25 seconds, Saybolt Furol, at 122° F., shall be tested on the Saybolt Universal at 122° F. Oil showing a time of less than 32 seconds, Saybolt Universal, at 122° F., shall be measured in the Saybolt Universal at 100° F. (37.8° C.). These methods of test do not apply to fuels having a viscosity at 100° F. of less than 32 seconds Saybolt Universal, which are not considered to be fuel oils.

Section 4.—Change the first paragraph to read as follows, by the addition of the italicized words and figures and the omission of the word in brackets:

> 4. [In] *For* tests at *77*, 100, *122* and 130° F. (*25*, 37.8, *50* and 54.4° C.) the bath temperature throughout the test shall not vary more than ±0.1° F. (0.06° C.) from the predetermined temperature which will maintain thermal equilibrium as long as the oil is well stirred with the thermometer. In tests at 210 *and 212° F.* (98.9 *and 100° C.*) a variation of ±0.2° F. (0.11° C.) is permitted.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 427.

Change the first sentence of the second paragraph to read as follows, by the addition of the italicized words and figures and the omission of the words in brackets:

> Any construction of bath may be employed provided the bath temperature necessary to maintain thermal equilibrium (while the oil in the oil tube is well stirred by the oil tube thermometer) *is within* ±*0.1° F.* (*0.06° C.*) *from the standard temperature of 77° F.* (*25° C.*) *or* is not in excess of 100.25, 122.35, 130.50 [and] 212.00 *or 214.00° F.* (37.9, 50.2, 54.7 [and] 100.00 *and 101.1° C.*) respectively, for the *other* standard temperatures previously mentioned.

2. *Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products* (*D 86 – 27*).[1]—The following change is recommended by Sub-Committee VIII on Distillation (E. W. Dean, chairman) to provide for choice of thermometer on the basis of maximum temperature as well as initial boiling point:

Section 8 (*d*).—Change the footnote to this section from its present form: namely,

> For products having an initial boiling point of 212° F. (100° C.) or higher, the High-Distillation Thermometer shall be used; for all other products, the Low-Distillation Thermometer shall be used.

to read as follows:

> For products having end points not higher than 482° F. (250° C.) or initial boiling points not higher than 212° F. (100° C.), the Low-Distillation Thermometer shall be used; for all other products, the High-Distillation Thermometer shall be used.

3. *Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials* (*D 95 – 28*).[1]—To clarify the meaning and the procedure, the following changes are recommended by Sub-Committee XIV on Water and Sediment (H. R. Gundlach, chairman):

Section 5.—Change the last sentence to read as follows, by the addition of the italicized words and figures and the omission of the figure in brackets:

> The end of the condenser to be inserted in the trap shall be ground off at an angle of [60] *30* deg. *from the vertical axis of the condenser.*

Section 9.—Add the following sentence after the first sentence of the second paragraph:

> The end of the condenser inserted in the trap shall be adjusted to that position which will allow the end to be submerged to a depth of not more than 1 mm. below the surface of the liquid in the trap after distillation conditions have been established.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378.

4. *Standard Method of Test for Carbon Residue of Petroleum Products (Conradson Carbon Residue) (D 189 - 28).*[1]—The following change is recommended by Sub-Committee XXIII on Carbon Residue to increase the tolerance on the weight of the spun sheet-iron crucible:

Section 2 (c).—Change the first sentence to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

> Spun sheet-iron crucible, with cover; about 200-ml. (7-oz.) capacity, 80 mm. (3⅛ in.) in outside diameter at the top, 58 to 60 mm. (about 2⅜ in.) in height, approximately 0.8 mm. ($\frac{1}{32}$ in.) in thickness and weighing, without cover, [70 to 75 g. (about 2½ oz.)] *65 to 85 g. (about 2¼ to 3 oz.).*

ACTIVITIES OF SUB-COMMITTEES

Appended hereto are reports of the following sub-committees:

- Sub-Committee III on Paraffin Wax
- Sub-Committee VII on Sulfur Determination and Differentiation
- Sub-Committee IX on Precipitation
- Sub-Committee XI on Turbine Oils
- Sub-Committee XXIII on Carbon Residue
- Sub-Committee XXV on Crankcase Dilution
- Joint Committee with American Leather Chemists Association on Cold Test of Fatty Oils.

In addition to the sub-committee reports appended, the activities of two other sub-committees are presented:

Report of Sub-Committee XXII on Natural Gas Gasoline (G. G. Oberfell, chairman).—Sub-Committee XXII is taking up the determination of the vapor pressure of gasoline. The Reid vapor-pressure method, adopted by the Natural Gasoline Association of America and recommended by the American Petroleum Institute to the Bureau of Explosives as a substitute for the present official method for transportation classification of gasolines, appears to be satisfactory for this use, but possibly a more sensitive method will be found desirable for testing gasoline of relatively low vapor pressure. A correlation of existing information on vapor pressures and A.S.T.M. distillations of volatile petroleum products is to be undertaken prior to recommending a vapor-pressure method as an A.S.T.M. Standard.

Report of Sub-Committee XXX on Fuel Oils (Harold Farmer, chairman).—During the past year the sub-committee has directed its efforts to a study of the relations of sediment values in conjunction with ash values (incombustible residue) of heavy fuel oils. Preliminary work indicates that fuel oils having identical sediment values may differ materially with respect to the amount of incombustible matter present in the sediments. Further study is necessary to interpret properly the significance of the application of tests of this character with respect to burning and storage of the fuel. It is also desirable that a test be developed which will indicate whether oils from different sources can be combined in storage without precipitating sediment.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 129.

The sub-committee has been appointed to act in the capacity of a standing committee for the Recommended Commercial Standards for Domestic and Industrial Fuel Oils of the Commerical Standards Unit of the U. S. Bureau of Standards. The standing committee will receive all comments and suggestions for improvement of the specification and will meet once a year to consider any proposed changes.

The recommendations appearing in this report have been submitted to letter ballot of the committee, which consists of 81 members; 52 ballots have been returned and 29 members have refrained from voting. The result of the letter ballot is as follows:

Items	Affirmative	Negative	Not Voting
I. PROPOSED NEW TENTATIVE METHOD			
Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes	46	0	6
II. PROPOSED TENTATIVE REVISION OF STANDARDS			
Standard Method of Test for Viscosity of Petroleum Products and Lubricants (D 88 - 26)	52	0	0
Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (D 86 - 27)	50	1	1
Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 - 28)	50	0	2
Standard Method of Test for Carbon Residue of Petroleum Products (Conradson Carbon Residue) (D 189 - 28)	48	1	3
III. PROPOSED REVISION OF TENTATIVE STANDARDS			
Tentative Method of Test for Sulfur in Naphthas and Illuminating Oils (D 90 - 26 T)	47	0	5
Tentative Method of Test for Precipitation Number of Lubricating Oils (D 91 - 21 T)	45	1	6

This report has been submitted to letter ballot of the committee, which consists of 81 members; 49 members returned their ballots, of whom 49 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

F. A. HULL,
Chairman.

R. P. ANDERSON,
Secretary.

EDITORIAL NOTE

The proposed Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes was accepted for publication as tentative and appears on page 682.

The proposed tentative revisions of the Standard Methods of Test for Viscosity of Petroleum Products and Lubricants; Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products; Test for Water in Petroleum Products and Other Bituminous Materials; and Test for Carbon Residue of Petroleum Products (Conradson Carbon Residue), were accepted for publication as tentative and appear on pages 869 and 870.

The proposed revisions of the Tentative Method of Test for Sulfur in Naphthas and Illuminating Oils and Test for Precipitation Number of Lubricating Oils were accepted. The methods as revised appear on pages 697 and 694, respectively.

Revisions of the Tentative Method of Test for Distillation of Crude Petroleum, proposed on the floor of the annual meeting, were accepted for publication as tentative subject to a favorable retroactive letter ballot of the committee. The retroactive letter ballot of the committee resulted in 50 affirmative and no negative votes; 31 members failed to return their ballots. The method as revised appears on page 687.

REPORT OF SUB-COMMITTEE III ON PARAFFIN WAX

The work of the sub-committee during the past year consisted of an intensive study of the factors involved in the determination of oil and moisture by the press method in the chairman's laboratory; the preparation of a standardized procedure for the determination of expressible oil and moisture in paraffin waxes, making use of water-cooled press platens developed in the chairman's laboratory; and cooperative tests on six samples of wax by six laboratories with the standardized procedure. This program was decided upon after it had become evident that the technique of the various methods for the determination of total oil content, studied in previous years, was too difficult to permit a reasonable degree of reproducibility in the hands of the average operator in the cooperating laboratories, and after it had become apparent that the need for a method for the determination of expressible oil was greater than that for a method of determining total oil.

The apparatus and procedure developed as a result of the sub-committee's work is described in the appended Proposed Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes.[1] Six samples of paraffin wax, adjusted to total oil contents as indicated by analysis by the Solvent Index of Refraction and Solidification Point Methods and as shown in the accompanying Table I, were tested by the proposed procedure in six laboratories. The percentages of oil were selected so as to represent maximums which commercial waxes of the types to which the method is applicable are not likely to exceed.

The results of the cooperative tests, obtained by the use of three pressings of 15 minutes each, are shown in Table I.

The following table shows the results obtained by laboratory No. 6, the time of each pressing being reduced to five minutes:

EXPRESSIBLE OIL AND MOISTURE

	Description of Wax Sample		Individual Determinations, per cent				Average Corrected by Equation,[a] per cent	Grand Corrected Average, All Laboratories 15 Minutes Pressing, per cent
	Melting Point	Total Oil	(1)	(2)	(3)	Average		
A.	130° F.	0.0 per cent	0.3	0.3	0.3	0.3	0.0	0.1
B.	122° F.	0.0 " "	0.5	0.3	0.2	0.3	0.0	0.0
C.	130° F.	2.5 " "	0.5	0.4	0.5	0.5	0.2	0.3
D.	122° F.	2.5 " "	1.0	1.1	1.0	1.0	0.7	0.7
E.	108 - 110° F.	2.5 " "	1.7	1.3	1.7	1.6	1.3	1.2
F.	108 - 110° F.	5.0 " "	2.7	2.2	2.5	2.4	2.1	3.0

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[a] See the proposed Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes, p. 682.

[1] See p. 682.—ED.

TABLE I.—SUMMARY OF RESULTS OF COOPERATIVE WORK ON THE PRESS METHOD FOR DETERMINATION OF EXPRESSIBLE OIL AND MOISTURE IN PARAFFIN WAX.

Laboratory	Expressible Oil and Moisture					
	Individual Determinations, per cent			Average, per cent	Average, Corrected by Equation,[a] per cent	Deviation of Corrected Average from Grand Corrected Average, per cent
	(1)	(2)	(3)			
SAMPLE A.—130° F. MELTING POINT WAX CONTAINING 0.0 PER CENT TOTAL OIL.						
No. 1	0.6	0.2	0.0	0.3	0.0	−0.1
No. 2	0.2	0.4	0.2	0.3	0.0	−0.1
No. 3	0.4	0.7	0.5	0.5	0.2	+0.1
No. 4	1.0	0.4	0.4	0.6	0.3	+0.2
No. 5	0.6	0.6	0.9	0.7	0.4	+0.3
No. 6	...	...	...	0.2[b]	0.0	−0.1
Grand Average, all laboratories, corrected by equation[a] .... 0.1 per cent						
SAMPLE B.—122° F. MELTING POINT WAX CONTAINING 0.0 PER CENT TOTAL OIL.						
No. 1	0.0	0.0	0.0	0.0	0.0	0.0
No. 2	0.9	1.0	0.3	0.7	0.4	+0.4
No. 3	0.5	0.5	0.2	0.4	0.1	+0.1
No. 4	0.7	...	0.6	0.7	0.4	+0.4
No. 5	0.0	0.0	0.0	0.0	0.0	0.0
No. 6	...	...	...	0.2[c]	0.0	0.0
Grand Average, all laboratories, corrected by equation[a] .... 0.0 per cent						
SAMPLE C.—130° F. MELTING POINT WAX CONTAINING 2.5 PER CENT TOTAL OIL.						
No. 1	0.1	0.0	0.0	0.0	0.0	−0.3
No. 2	0.6	0.9	1.3	0.9	0.6	+0.3
No. 3	1.0	0.9	1.0	1.0	0.7	+0.4
No. 4	0.8	0.6	0.8	0.7	0.4	+0.1
No. 5	0.0	0.3	0.0	0.1	0.0	−0.3
No. 6	...	...	...	0.6[b]	0.3	0.0
Grand Average, all laboratories, corrected by equation[a] .... 0.3 per cent						
SAMPLE D.—122° F. MELTING POINT WAX CONTAINING 2.5 PER CENT TOTAL OIL.						
No. 1	0.4	0.7	0.7	0.6	0.3	−0.4
No. 2	1.2	2.5	1.5	1.7	1.4	+0.7
No. 3	1.2	1.4	1.2	1.3	1.0	+0.3
No. 4	...	0.8	1.0	0.9	0.6	−0.1
No. 5	0.2	0.1	...	0.2	0.0	−0.7
No. 6	...	...	...	1.2[c]	0.9	+0.2
Grand Average, all laboratories, corrected by equation[a] .... 0.7 per cent						
SAMPLE E.—108 to 110° F. MELTING POINT WAX CONTAINING 2.5 PER CENT TOTAL OIL.						
No. 1	1.3	0.7	0.8	0.9	0.6	−0.6
No. 2	2.9	2.3	2.7	2.6	2.3	+1.1
No. 3	2.5	2.0	2.2	2.2	1.9	+0.7
No. 4	1.5	1.5	1.6	1.5	1.2	0.0
No. 5	...	0.6	0.4	0.5	0.2	−1.0
No. 6	1.2	1.1	1.8	1.4	1.1	−0.1
Grand Average, all laboratories, corrected by equation[a] .... 1.2 per cent						
SAMPLE F.—108 TO 110° F. MELTING POINT WAX CONTAINING 5.0 PER CENT TOTAL OIL.						
No. 1	...	2.8	2.6	2.7	2.4	−0.6
No. 2	4.5	4.4	3.5	4.1	3.8	+0.8
No. 3	3.8	4.7	3.3	3.9	3.6	+0.6
No. 4	3.4	3.4	3.5	3.4	3.1	+0.1
No. 5	2.5	3.2	2.6	2.8	2.5	−0.5
No. 6	2.9	2.7	3.2	2.9	2.6	−0.4
Grand Average, all laboratories, corrected by equation[a] .... 3.0 per cent						

[a] See the proposed Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes, p. 682.

[b] Average of 30 determinations.

[c] Average of 6 determinations.

As indicated by extensive work in the chairman's laboratory, and as is evident from the results given in the table, the expressible oil and moisture does not bear a simple and direct relation to the total oil content. However, as commercial paraffin waxes have been almost universally evaluated for many years on the basis of their expressible oil and moisture content, and as these characteristics appear to be of more practical significance than the total oil content, the differences between total oil and expressible oil and moisture revealed in the table are of no importance in this connection.

The sub-committee submits the Proposed Tentative Method of Test for Expressible Oil and Moisture in Paraffin Waxes, as appended hereto,[1] for approval as a tentative standard.

Respectfully submitted on behalf of the sub-committee,

J. B. RATHER,
Chairman.

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[1] See p. 682.—ED.

REPORT OF SUB-COMMITTEE VII ON SULFUR DETERMINATION AND DIFFERENTIATION

The work of Sub-Committee VII during the past year has been concerned with revising the procedure for the lamp method (Tentative Method of Test for Sulfur in Naphthas and Illuminating Oils (D 90 - 26 T)[1] of determining sulfur in motor fuels, naphthas, and illuminating oils, with the purpose of making it possible for analysts not especially familiar with the method to obtain more uniform and more accurate results than have been possible in the past, and also to make the method applicable to mixtures containing carbon bisulfide. Although, when used correctly, the tentative method in its existing form yields good results (see *Proceedings*, Vol. 24, Part I, p. 525, (1924)), the experience has been that some laboratories attempting to follow the procedure have not obtained dependable results, presumably because the dimensions of the apparatus and the details of manipulation were not specified in sufficient detail. For this

TABLE I.—COMPARISON OF SULFUR DETERMINATIONS IN DIFFERENT LABORATORIES ON A COMMERCIAL MOTOR GASOLINE.

Laboratory	Weight of Sample, g.	Time of Burning, minutes	Percentage Sulfur Found	Deviation from Average	Deviation from Grand Average of All Laboratories
No. 1.	2.00	55	0.0425	+0.0022	
	1.59	40	0.038	−0.0023	
	1.73	45	0.040	−0.0003	
	1.87	50	0.040	−0.0003	
	1.96	55	0.041	+0.0007	
Average	....	....	0.0403		−0.0040
No. 2.	2.924	90	0.0475	+0.0010	
	2.243	60	0.0455	−0.0010	
	2.107	60	0.0465	0.0000	
	1.747	60	0.0464	−0.0001	
Average	....	....	0.0465		+0.0022
No. 3.	2.247	60	0.038	−0.0025	
	1.859	60	0.043	+0.0025	
Average	....	....	0.0405		−0.0038
No. 4.	3.052	75	0.043	−0.002	
	3.023	75	0.049	+0 004	
	3.273	75	0.041	−0.004	
	3.205	75	0.047	+0.002	
Average	....	....	0.045		+0.007
No. 5.	2.617	70	0.0382	−0.0014	
	2.227	60	0.0405	+0.0009	
	1.992	60	0.0402	+0.0006	
Average	....	....	0.0396		−0.0047
No. 6	2.331	90	0.035	−0.0027	
	2.598	120	0.039	+0.0013	
	2.350	120	0.039	+0.0013	
Average	....	....	0.0377		−0.0066
No. 7	1.960	60	0.0505	+0.0007	
	2.162	60	0.0491	−0.0007	
	2.125	60	0.0508	+0.0010	
	2.162	60	0.0486	−0.0012	
Average	....	....	0.0498		+0.0055
No. 8	1.657	70	0.0573	+0.0008	
	2.257	60	0.0564	−0.0001	
	2.841	60	0.0558	−0.0007	
Average	....	....	0.0565		+0.0122
No. 9	2.160	60	0.0592	+0.0032	
	2.121	60	0.0528	−0.0032	
Average	....	....	0.0560		+0.0117
No. 10.	1.880	60	0.032	....	−0.0123
No. 11	2.125	35	0.035	−0.0023	
	2.610	45	0.038	+0.0007	
	1.760	30	0.039	+0.0017	
Average	....	....	0.0373		−0.0070

Grand Average, all laboratories, 0.0443 per cent sulfur.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 848 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 443.

reason the present revisions have consisted in settling upon definite form and dimensions of apparatus and in writing the test of the method in a still more specific way. Three series of cooperative analyses have been made as a part of this work.

The sub-committee recommends that the apparatus and method in its revised form as appended hereto,[1] be approved as a Tentative Method of Test for Sulfur in Motor Fuels, Naphthas, and Illuminating Oils (Lamp Method). Results of cooperative tests by members of the sub-committee, using the apparatus and method in the revised form, are contained in Tables I and II.

TABLE II.—COMPARISON OF SULFUR DETERMINATIONS IN DIFFERENT LABORATORIES ON A MOTOR GASOLINE CONTAINING CARBON BISULFIDE.[a]

Laboratory	Weight of Sample, g.	Time of Burning, minutes	Percentage Sulfur Found	Deviation from Average	Deviation from Grand Average of All Laboratories
No. 1	1.71	45	0.204	0.000	
	1.87	45	0.198	−0.006	
	1.81	45	0.201	−0.003	
	2.11	60	0.199	−0.005	
	2.43	60	0.208	+0.004	
	2.40	60	0.206	+0.002	
	2.43	65	0.208	+0.004	
	2.28	65	0.208	+0.004	
Average	......	....	0.204		+0.0066
No. 2	1.840	60	0.204	+0.0025	
	1.431	60	0.203	+0.0015	
	1.718	60	0.193	−0.0085	
	1.682	60	0.206	+0.0045	
Average	......	....	0.2015		+0.0041
No. 3	2.849	60	0.203	+0.002	
	2.168	60	0.199	−0.002	
Average	......	....	0.201		+0.0036
No. 4	3.261	75	0.202	−0.0072	
	3.313	75	0.200	−0.0092	
	2.345	75	0.239	+0.0298	
	2.622	75	0.196	−0.0132	
Average	......	....	0.2092		+0.0118
No. 5	2.177	60	0.1906	−0.0016	
	2.184	60	0.1873	−0.0049	
	2.241	60	0.1986	+0.0064	
Average	......	....	0.1922		−0.0052
No. 6	2.495	120	0.194	+0.0015	
	3.232	120	0.191	−0.0015	
Average	......	....	0.1925		−0.0049
No 7	2.350	60	0.208	+0.0048	
	2.250	60	0.200	−0.0032	
	1.922	60	0.202	−0.0012	
	2.052	60	0.203	−0.0002	
Average	......	....	0.2032		+0.0058
No. 8	1.558	40	0.194	+0.0067	
	1.896	45	0.181	−0.0063	
	2.468	50	0.187	−0.0003	
Average	......	....	0.1873		−0.0101
No. 9	0.577	15	0.194	−0.0035	
	0.713	20	0.201	+0.0035	
Average	......	....	0.1975		+0.0001
No. 10	1.708	55	0.173		−0.0244
No. 11	1.605	30	0.178	+0.0033	
	2.000	40	0.172	−0.0027	
	1.610	30	0.174	−0.0007	
Average	......	....	0.1747		−0.0227

Grand Average, all laboratories, 0.1974 per cent sulfur.

[a] Prepared by adding 4.9359 g. of carbon bisulfide, redistilled and ends discarded, to 3300 cc. of commercial motor gasoline used in Table I. Specific gravity of gasoline was 0.741 at 60°/60° F. Hence, the theoretical sulfur content in this sample was 0.1697 per cent + 0.0443 per cent, or about 0.214 per cent.

Respectfully submitted on behalf of the sub-committee,

T. A. BOYD,
Chairman.

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[1] See p. 697.—ED.

REPORT OF SUB-COMMITTEE IX ON PRECIPITATION

In the 1928 report[1] of Sub-Committee IX, it was shown that in order to obtain uniform results with the Tentative Method of Test for Precipitation Number of Lubricating Oils (D 91 - 21 T) it is necessary to use as a diluent a naphtha with an aniline point range from 58 to 60° C. It was shown further that all the specification naphthas which had aniline points between 58 and 60° C. gave satisfactory precipitation values despite the fact that they had been obtained from crude oils of different sources and prepared in different laboratories.

TABLE I.—A.S.T.M. PRECIPITATION NUMBERS.[a]

Oil	Source of Naphtha	Precipitation Numbers									
		Laboratory No. 1	Laboratory No. 2	Laboratory No. 3	Laboratory No. 4	Laboratory No. 5	Laboratory No. 6	Laboratory No. 7	Laboratory No. 8	Laboratory No. 9	Laboratory No. 10
A	Tide Water Oil Co.[b]	0.20 0.20	0.20	0.15	0.15 0.15	0.10	0.15 0.15	0.10 0.10	0.19 0.18	0.20	0.20
	Laboratory Conducting Test	0.20 0.20	0.25	0.15	0.17 0.17	....	....	0.10 0.10	0.21 0.19	0.20	....
B	Tide Water Oil Co.[b]	1.20 1.20 1.10	1.20	1.30	1.25 1.30	0.75	0.85	1.20	1.50	1.20	1.05
	Laboratory Conducting Test	1.10 1.10	1.15	1.30	1.40 1.35	....	....	1.10 1.10	1.40 1.25	1.10	....
C	Tide Water Oil Co.[b]	3.00 3.00 3.00	3.50	4.10	3.50 3.50	1.60	1.90 1.90	2.2 2.1	3.20 3.20	2.30	2.05
	Laboratory Conducting Test	3.00 2.90	2.90	3.70	3.50 3.60	....	....	2.40 2.40	3.20 3.50	2.30	....
	Aniline point (deg. Cent.) of naphthas supplied by individual laboratories	....	58.0	57.0	58.7 58.6	....	....	58.8	60.3	54.4	....

[a] The type of test and of results reported in this table does not warrant the inclusion of the average deviation from the mean.

[b] Aniline point 58.7° C.

During the past year, the chairman has distributed samples of three oils, accompanied by a naphtha prepared in his laboratory conforming to the following requirements:

Gravity, deg. A.P.I. at 60° F	70 to 73
Aniline Point, deg. Cent	58 to 60
Initial Boiling Point, A.S.T.M	Not less than 122° F. (50° C.)
50-per-cent Point, A.S.T.M	158 to 176° F. (70 to 80° C.)
End Point, A.S.T.M	Not more than 266° F. (130° C.)

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 450 (1928).

Similar naphthas have also been prepared by other members of the sub-committee and the tentative Precipitation Method D 91 has been carried out on these samples by ten laboratories using the special naphthas as diluents. The results are contained in Table I.

On the basis of this experimental work, the sub-committee recommends that the requirements for the naphtha specified in Section 5 of the Tentative Method of Test for Precipitation Number of Lubricating Oils (D 91 - 21 T) be changed to that shown above. A slight change is also recommended in the calibration of the centrifuge tube to increase the accuracy of reading. The revisions are given in detail in the body of the report.

DEVELOPMENT OF A NEW GRAVIMETRIC SEDIMENT TEST

Some time ago the sub-committee was requested to investigate other tests now in use on certain types of oils, such as the Holde Tar Test, the U. S. Railway Tar Test, etc., in order either to standardize one of these tests or to develop a new method of the gravimetric type. A new gravimetric sediment test has been developed by Mr. Rothbard, in the chairman's laboratory, which seemed to have considerable interest for this sub-committee and also for members of Sub-Committee XXX on Fuel Oil. This is a gravimetric test rather than a volumetric test such as the precipitation number and does not necessarily bear any definite relation to the precipitation numbers obtained.

A set of samples was recently circulated to the members of the sub-committee for the purpose of checking the results which had been obtained in the chairman's laboratory.

This report submits a detailed description of a new gravimetric method for the determination of sediment in petroleum products together with a comparison of results obtained by this new method, the present tentative A.S.T.M. precipitation method and the various gravimetric methods; namely, the Phillips Method, the Holde Method and the U. S. Railway Administration Method, on a large number of samples representing various grades of stock from Pennsylvania, Mid-Continent and California Crudes.

The proposed method is as follows:

Weigh 1.5 to 2.5 g. of the oil into a tared A.S.T.M. centrifuge tube.[1] If the sample is low in sediment or if its viscosity is low the weight of oil sample may be increased to 5 g. Dilute the sample to the 100-cc. mark with the new A.S.T.M. specification naphtha, and then close the tube with a well-fitting cork stopper, shake until the oil is thoroughly mixed with the diluent and place in a water bath, maintained at a temperature of from 90 to 95° F., for 15 minutes.

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[1] For dimensions of this tube see *Proceedings*, Am. Soc. Testing Mats., Vol. 21, p. 649 (1921); also the 1928 Book of A.S.T.M. Tentative Standards, p. 441.

At the end of 15 minutes place the tube in the centrifuge, and, after proper adjustments are made, centrifuge for 10 minutes at a speed of 1500 r.p.m.[1] Remove the tube and examine the sample. If the solution above the precipitate is transparent to transmitted light, it indicates that complete settling of the sediment has been accomplished. If, however, the solution is not clear, it is necessary to centrifuge the sample for three or four additional 10-minute periods in order to insure complete settling.

Carefully decant the solution above the precipitate, then invert the tube and allow it to drain in this position for 10 minutes. Wipe the neck of the tube clean and pour about 8 cc. of the new A.S.T.M. precipitation naphtha taking care not to disturb the precipitate. If a slight disturbance is noted, allow the sample to stand for 5 minutes. This procedure insures the settling of the disturbed particles.

Carefully tilt the tube into a horizontal position and rotate it by hand until the oil adhering to the inner sides is completely dissolved. Decant the solution and drain the tube as before for 5 minutes, then direct a small current of dry air against the precipitate for a few seconds in order to insure the removal of the last traces of the diluent.

Add 10 cc. of warm c. p. chloroform to the tube and shake the contents for a short period of time, then pour the solution into a tared crystallizing dish (6.0 cm. in diameter and 3.5 cm. in height). Repeat this procedure until the added portion of the solvent remains colorless. Usually the total volume required to effect complete solution of the sediment is 30 cc.

Place the dish containing the solution in an oven maintained at a temperature of 110° C., and after the complete removal of the solvent, place in a desiccator, cool and weigh. Repeat this operation until constant weight is obtained. This gives the weight of the sediment contained in the sample and is reported as such.

NOTE.—If it is desired to determine grit or the amount of chloroform-insoluble constituents, the sediment is redissolved in warm chloroform, the solution is filtered through a tared Gooch crucible by means of suction after which the crucible is washed with warm chloroform until the solvent comes through colorless. The crucible is dried in the oven, cooled and weighed. The increase in weight gives the weight of grit or chloroform-insoluble material contained in the sample.

The naphtha which was used throughout this investigation conformed with the new requirements for A.S.T.M. precipitation naphtha. Its aniline point was 59.4° C.

There is given below a table of data showing the comparison between the new method, the A.S.T.M. precipitation method (D 91 – 21 T) and several gravimetric methods, namely, the Phillips method, the U. S. Railway Administration method and the Holde method.

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[1] A full description of the centrifuge and method of adjustment is given in the Tentative Method of Test for Precipitation Number of Lubricating Oils (D 91 – 21 T), see *Proceedings*, Am. Soc. Testing Mats., Vol. 21, p. 648; also 1928 Book of A.S.T.M. Tentative Standards, p. 440.

When the tentative A.S.T.M. precipitation test is performed upon a viscous oil containing a fairly large amount of sediment, from 15 to 25 ten-minute spins will be required before constant readings are obtained. Furthermore, in this process of settling by centrifuge a certain amount of oil is brought down with the precipitate which even with the repeated number of spins may at times retain a sufficient amount of oil to give high results. An examination of the precipitate obtained from sample No. 3 has disclosed the fact that it contained about 48 per cent of the diluent soluble material. In centrifuging the sediment in the new method this oil occlusion is reduced to a negligible quantity due to the fact that the ratio of the diluent to oil is about five times greater than in the A.S.T.M. precipitation test.

TABLE II.—COMPARISON OF VARIOUS PRECIPITATION METHODS.

PRECIPITATION NUMBER

SAMPLE	NEW METHOD	PHILLIPS METHOD	A.S.T.M. METHOD D 91 - 21 T	U. S. RAILWAY METHOD	HOLDE METHOD
No. 1	0.22	0.23	0.24	0.18	0.18
No. 2	2.11	1.61	1.12	1.34	1.63
No. 3	3.72	3.99	3.12	3.04	4.59
No. 5	0.80	0.86	0.82	1.38	1.18
No. 6	0.44	0.42	0.17	0.38	0.21
No. 7	0.03	0.11	0.02[a]	0.08	0.04
No. 8	0.07	0.05	0.01[a]	0.05	0.06
No. 9	0.17	0.18	0.04	0.17	0.11
No. 10	0.79	0.72	0.38	0.65	0.71
No. 11	0.04	0.08	0.02[a]	0.06	0.13
No. 12	0.04	0.06	0.03[a]	0.07	0.10
No. 13	1.66	1.46	0.90	1.44	1.35
No. 16	0.46	0.32	0.40	0.33	0.48
No. 17	0.08	0.13	0.13	0.08	0.11
No. 18	0.12	0.12	0.13	0.09	0.14
No. 19	0.05	0.08	0.07	0.07	0.08
No. 20	1.22	0.90	0.37	1.12	1.11
No. 21	2.25	2.09	0.40	2.40	2.20
No. 22	2.45	2.40	0.37	2.05	2.44
No. 23	2.56	2.48	0.45	2.14	2.70

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[a] Estimated.

In performing other gravimetric tests on a sample, particularly one having a high precipitation number, it is to be noted that generally all involve filtration and the transfer of the precipitate from a flask into a weighed Gooch crucible. The success of the latter operation depends largely upon the manipulative skill of the operator.

In the new gravimetric sediment test the filtration and the transfer of the precipitate are entirely eliminated. The precipitate is left in the tapered part of the tube and there it is treated with the solvent until complete solution is accomplished.

Cooperative testing with this method is now under way.

Sub-Committee XXX on Fuel Oils has expressed a desire to investigate this new method in order to determine its applicability to fuel oils.

Conclusions:

A new gravimetric sediment test has been developed which is believed to have the following advantages:

1. It is simple, rapid and reproducible.
2. It does not involve filtration and transfer of the precipitate.
3. It does not involve any special manipulating skill.
4. It minimizes the time factor which is involved in all gravimetric tests and which is often of considerable importance.

Respectfully submitted on behalf of the sub-committee,

L. W. PARSONS,
Chairman.

REPORT OF SUB-COMMITTEE XI ON TURBINE OILS

The program of cooperative tests on turbine oils planned by this sub-committee and Sub-Committee X on Oxidation at High Temperatures[1] has been carried out.

Samples of six oils that have been giving satisfactory service performance to the users were tested, and five laboratories reported results of Sligh oxidation values for these samples. The results were as follows:

	Sample					
	No. 1–28	No. 2–28	No. 4–28	No. 4–28 (Heavy)	No. 5–28	No. 6–28
Average oxidation value, five laboratories..............	12.5	58.9	11.6	20.3	10.3	28.0
Average deviation in per cent.	12.8	20	15.2	15.3	6.2	28.6

The committee feels that the results indicate a very fair degree of reproducibility for the Sligh oxidation test.

The Turbine Oil Sub-Committee for its future work will consider the application of the Sligh test as an index to service performance of an oil.

The sub-committee feels that while the Sligh test shows a very fair degree of reproducibility for the method, it may not be satisfactory for predicting service performance and for that reason other oxidation or performance tests should be considered, such as Rogers' test, Funk Oil-Testing Machine, the apparatus employed by the Naval Engineering Experiment Station, and any other test which may be employed as an index for the prediction of satisfactory performance of an oil in service.

The sub-committee will send out samples of not less than five nor more than eight turbine oils to its members and to other laboratories which have expressed a desire to cooperate in this work.

The cooperating laboratories will be asked to make the following tests on all samples:

1. Steam Emulsion Test (A.S.T.M. Method D 157);
2. Sligh oxidation test;
3. Rogers' test;
4. Funk test (if apparatus is available);
5. Navy test (if apparatus is available);
6. Any test which may be employed by individual laboratories in the selection of satisfactory turbine oil.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 457 (1928).

The cooperating laboratories will be requested to express an opinion regarding the possible performance of the oil in service based upon the tests which they employ.

A certain number of these oils which may be found to rank in a definite order by laboratory tests will be selected and these oils run under carefully observed conditions in service.

Respectfully submitted on behalf of the sub-committee,

HAROLD FARMER,
Chairman.

During this year, two suppliers of instruments to the oil trade objected to the narrow limits for the weight of the spun sheet-iron crucibles specified in the Standard Method of Test for Carbon Residue of Petroleum Products (Conradson Carbon Residue) (D 189 – 28).[1] Both suppliers stated that the limits of 70 to 75 g. (about $2\frac{1}{2}$ oz.) cannot be easily complied with and requested a greater tolerance.

TABLE I.—COMPARISON OF CARBON-RESIDUE DETERMINATIONS BY TWO LABORATORIES ON TWO DIFFERENT OILS.

SAMPLE	LABORATORY	PRE-IGNITION PERIOD, MINUTES	BURNING PERIOD, MINUTES	FINAL PERIOD, MINUTES	TOTAL TIME, MINUTES	CARBON RESIDUE, PER CENT
No. 1	Vacuum Oil Co.	11.5	13.0	7.0	31.5	3.88
		10.5	14.0	7.0	31.5	3.93
					Average	3.90
	The Atlantic Refining Co.		13.5	7.0	31.0	3.84
		10.5	13.0	7.0	31.0	3.83
		11.0	Time not noted			3.79
			Time not noted			3.90
					Average	3.84
No. 2	Vacuum Oil Co.	11.5	12.5	7.0	31.0	1.50
		10.5	11.5	7.0	29.0	1.50
					Average	1.50
	The Atlantic Refining Co.		13.0	7.0	30.0	1.69
		10.0	15.0	7.0	32.0	1.70
		10.0	Time not noted			1.46
			Time not noted			1.59
					Average	1.61

The sub-committee agrees that the limits should be changed to read 65 to 85 g. (about $2\frac{1}{4}$ to 3 oz.) and recommends a tentative revision of the standard method in this respect.

Criticisms were also made of the procedure but the sub-committee feels that the report submitted does not warrant recommending that the method be withdrawn or again made tentative. This report covered regular tests, including carbon residue determinations on a sample of bright stock which had been submitted to ten cooperating laboratories. Two of the carbon residues were so low that, following the usual practice in computing averages, they should have been discarded. Omitting these, all the remaining results are within the range of 10 per cent each side of the average, or a total range of 20 per cent.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 129.

One of the criticisms is against the range in time of burning, with the suggestion that it be narrowed, but reference to Table III of the 1927 report of Sub-Committee XXIII[1] will show that the accuracy of the method depends on strict attention to the different burning periods rather than on a narrower range. Runs Nos. 1 and 2 in that table show what happens during the stewing down "burning period" when unnecessarily prolonged to overcome the effect of a too rapid "pre-ignition" period. All results given in the table were secured by an operator who has had long experience with the test and were taken purposely to learn what would happen by varying the time in the different periods. The heat must be applied at a steadily increasing rate as in any distillation, with the flame held between the top of the chimney and the bridge, if reproducible results are expected.

The Atlantic Refining Co. submitted two samples for test, the results of which, given in Table I, show the reproducibility of the method.

Respectfully submitted on behalf of the sub-committee,

FLORUS R. BAXTER,
Chairman.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 475 (1927).

REPORT OF SUB-COMMITTEE XXV ON CRANKCASE DILUTION

The early work of this sub-committee during 1926 and 1927 covered comparative tests mainly with reference to the Sligh capillary tube method. In 1927 several laboratories carried out tests on fresh oils running the dilution by the Sligh method on samples of known dilution. In general the results indicated that the Sligh method gave reasonably concordant results. Also a few results were reported on the vapor-temperature distillation method which had been proposed as a substitute for this. Since that time several practical objections to the Sligh method have been reported, particularly on used oils. Trouble due to water was experienced and at the annual meeting in 1928 it was decided to drop the Sligh method and to concentrate attention on used oils with particular reference to the vapor-temperature distillation method.

Vapor-Temperature Distillation Method:

The vapor-temperature method involves a simple distillation, substantially by the A.S.T.M. Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products (D 86 – 27), reading off the amount of diluent at a vapor temperature which is supposed to be a practical definition of the point at which the diluent is all driven off and before which the oil begins to distill. This method has been used in the laboratory of the chairman with reasonable satisfaction for several years. Comprehensive tests were made during the development of this method and it was found that a vapor temperature of 460° F. gave results in agreement with known dilution on fresh oils when a naphtha representing the heavier part of gasoline is used as a diluent. The decision as to this temperature was arrived at as a result of quite a number of experiments which need not be recorded here. It has been felt that a very precise method for dilution is not required. No troubles with cracking have been exprienced but within the past year several reports of very discordant results with this method have come to the chairman.

Recently, a few tests were made to confirm the earlier work on this method. Tests were made with the thermometer in the liquid phase as well as the vapor phase and it was found that in general the bottom temperature ran 710 to 720° F. In view of the short time that the test was under way this would indicate that cracking should be negligible. Using a vapor temperature of 460° F., samples of known diluent content were checked within 0.5 per cent. One point which came up was the time when the reading should be taken and it was found that the results agreed best with the known diluent content, if the reading is taken just when the thermometer reads 460° F. without allowing time for drainage.

Last fall, samples of four used crankcase oils were sent out for cooperative work. The tentative description of the vapor-temperature method was included and this may best be described by saying that it is in accordance with the method for distillation of gasoline, A.S.T.M. Method D 86, with the exception that the asbestos boards are not used. It was thought that samples of low and of high dilution would present the most difficulty and accordingly the samples included the following:

Samples Nos. 1 and 3.—Ordinary crankcase drainings obtained at a service station.

Sample No. 2.—An S.A.E. No. 50 oil obtained from a test run in an engine on a block.

Sample No. 4.—Represents drainings from various Ford cars (Model T). To this sample was added a light (S.A.E. No. 10) motor oil and a diluent having a boiling range of 300 to 420° F. The drainings constituted about 60 per cent of the sample.

The data reported by various members of this sub-committee are given in Table I. It will be observed that these data show good agreement, both individually and as between separate laboratories. Sample No. 2 having a low dilution shows scarcely greater actual deviation than the others, but, as a result of a high percentage deviation on this sample, the average percentage deviation from the mean is 10.5. Altogether it is felt that this degree of precision is sufficient for a method of this kind and, were it not for the fact that some difficulties not encountered in these samples have been reported, this method might be considered acceptable. Some evidence of cracking having been obtained in work with samples of heavy oil with low dilution, attention has been paid to development of a steam distillation method as described below.

Steam Distillation Method:

A method for determining dilution by steam distillation analogous to the A.S.T.M. Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 – 28) has been independently developed by two separate laboratories. The Standard Oil Development Co.'s Inspection Laboratory has furnished an apparatus and description of the procedure to each member of the sub-committee. This method involves the use of a three-liter flask with a special trap for returning the water and measuring the petroleum distillate. A 100-cc. sample is used. Some results are reported in Table II showing comparative tests by this method.

TABLE I.—TABULATION OF RESULTS BY VAPOR TEMPERATURE DISTILLATION METHOD (460° F. END POINT).

Laboratory	Oil Sample No. 1			Oil Sample No. 2			Oil Sample No. 3			Oil Sample No. 4		
	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent
No. 1	7.5	7.3	0.0	2.0	3.0	28.6	9.0	9.5	8.2	22.5	22.8	0.4
	7.0		6.7	4.0		42.8	10.0		2.0	23.0		2.7
No. 2	7.3	7.2	2.7	2.0	2.5	28.6	9.3	8.7	5.1	22.0	21.9	1.8
	7.2		4.0	2.0		28.6	9.0		8.2	22.0		1.8
	7.0		6.7	3.1		10.7	8.5		13.3	22.3		0.4
	7.3		2.7	3.0		7.1	8.0		18.4	21.2		5.4
No. 3	9.0	8.8	20.0	3.0	3.0	7.1	11.0	11.2	12.3	23.5	23.5	4.9
	8.5		13.3	3.0		7.1	11.5		17.4	23.5		4.9
No. 4	6.5	6.5	13.3	3.0	2.8	7.1	10.0	10.0	2.0	22.5	22.8	0.4
	7.0		6.7	2.5		10.7	10.0		2.0	23.0		2.7
	6.0		20.0	3.0		7.1	10.0		2.0	22.8		1.8
No. 5	8.0	8.0	6.7	4.0	4.0	42.8	10.0	10.0	2.0	22.0	22.0	1.8
No 6	7.9	7.6	5.3	3.0	2.5	7.1	9.5	9.6	3.0	21.8	21.8	2.7
	7.8		4.0	2.0		28.6	10.0		2.0	22.0		1.8
	7.0		6.7	2.6		7.1	9.3		5.1	21.5		4.0
No. 7	7.6	7.4	2.7	2.5	2.3	10.7	9.3	9.6	5.1	22.0	22.1	1.8
	7.0		6.7	2.3		17.8	10.0		2.0	22.0		1.8
	7.5		0.0	2.1		25.0	9.5		3.0	22.3		0.4
No. 8	7.0	6.6	6.7	1.5	1.5	46.3	8.5	8.5	13.3	22.5	21.8	0.4
	6.8		9.3	1.0		64.4	9.0		8.2	21.5		4.0
	6.0		20.0	2.0		28.6	8.0		18.4	21.5		4.0
No. 9	8.7	8.5	16.0	3.8	3.7	35.7	11.0	11.0	12.3	22.9	23.0	2.2
	8.2		9.3	3.7		32.0	11.0		12.3	23.0		2.7
	8.5		13.3	3.6		28.6	11.0		12.3	23.0		2.7
Average, all laboratories	....	7.5	8.45	....	2.8	23.33	....	9.8	7.91	....	22.4	2.35

Average percentage deviation of all tests............10.51 per cent

The method developed by Mr. Wiley in the laboratory of the chairman uses a trap which is a modification of the trap used for the A.S.T.M. method for water. In general, smaller amounts of sample have been used inasmuch as there has been felt a desire for a compact apparatus suitable for mounting in a bank arrangement. Apparently, the experiences in the two laboratories have been quite similar. In order to prevent bumping it is necessary to use a relatively large flask compared to the size of the sample. The flask is filled about one-half full with water and the oil sample of course lies on top. Apparently the determining factor is the depth of the oil layer and it has been found that in order to prevent bumping in all cases this should be 0.5 cm. or less. The method requires several hours and in the laboratory of the chairman a set-up such as used for water determination with a lamp as a heater has generally been employed. The test can be quickly started and requires little attention thereafter.

TABLE II.—TABULATION OF RESULTS BY STEAM DISTILLATION METHODS.

Laboratory	Oil Sample No. 1			Oil Sample No. 2			Oil Sample No. 3			Oil Sample No. 4		
	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent	Dilution, per cent	Average Dilution, per cent	Deviation from Average of all Laboratories, per cent
STANDARD OIL DEVELOPMENT CO. METHOD (3 LITER FLASK; 100 CC. SAMPLE)												
No. 1	10.8	10.8	0.0	2.4	2.4	11.1	12.9	12.9	2.5	25.0	25.0	4.2
No. 2	11.3	11.3	4.6	3.0	3.0	11.1	12.2	12.2	3.2	27.3	27.3	4.6
No. 5	10.7	10.7	0.9	3.0	3.0	11.1	12.9	12.9	2.5	26.0	26.0	0.4
No. 7	9.8 10.1	10.0	9.3 6.5	2.7 2.7	2.7	0.0 0.0	12.8 12.6	12.7	1.6 0.0	26.2 25.6	25.9	0.4 1.9
No. 8	11.4	11.4	5.5	2.7 2.7	2.7	0.0 0.0	13.2 13.1	13.2	4.8 4.0	26.5 26.6	26.6	1.5 1.9
No. 9	10.8	10.8	0.0	2.2	2.2	18.5	11.6	11.6	8.0	25.6	25.6	1.9
Average, all laboratories	....	10.8	3.83	....	2.7	6.48	....	12.6	3.32	....	26.1	2.10
Average percentage deviation of Standard Oil Development Co. method tests........3.94 per cent												
STANDARD OIL CO. (INDIANA) METHOD (10 CC. SAMPLE; 500 CC. FLASK)												
No. 1	11.0 11.0	11.0	0.9 0.9	4.0 4.0	4.0	38.0 38.0	12.0 12.0	12.0	4.0 4.0	24.0 24.0	24.0	7.4 7.4
Averages, both methods, all laboratories	....	10.9	3.34	....	2.9	15.18	....	12.5	3.76	....	25.9	3.27
Average percentage deviation of all steam distillation tests............6.39 per cent												

By taking readings every 30 minutes the end point is taken when there is no substantial increase in amount of petroleum distillate. As a ready means of determining the end point it has been found that, with a trap equal in volume to the size of the sample, the end point is reached when the water, originally colored by a dye or a colored salt, is diluted so that color is no longer apparent. The time required is, of course, a function of the rate of boiling and in general takes three or four hours.

The amount of sample to be used is therefore a function of the size of the apparatus and work in the chairman's laboratory has been mainly with 50-cc. and 10-cc. samples using a 500-cc. flask and a 25-cc. and 10-cc. trap, respectively. With this equipment it has been found that with various grades of motor oil from light to heavy that the diluent found checks precisely with that added to a fresh oil. Tests on used oils have indicated that the 10-cc. sample is preferable. There is, of course, the objection to the use of so small a sample on the ground of accuracy in measuring the sample but it has been found very convenient to use a small glass capsule calibrated to 10 cc. which is dropped into the flask. With the use of a 10-cc. sample and A.S.T.M. water determination trap of 10-cc. capacity the graduations represent 1 per cent of the sample, and each graduation represents 1 per cent dilution. This may perhaps be too coarse a reading and it is believed that a 25-cc. sample with a 500-cc. flask and a trap of 10-cc. capacity might be an advantage. Also some promising results have been obtained with the use of a special electrical heater designed to fit the flask.

TABLE III.—GENERAL COMPARISON OF RESULTS BY VARIOUS METHODS.

		OIL SAMPLES			
		No. 1	No. 2	No. 3	No. 4
Vapor Temperature (460° F. end point) (Average, all members)		7.5	2.8	9.8	22.4
Steam Distillation (Average, all tests)		10.9	2.9	12.5	25.9
Sligh Method (A. E. Flowers)		10.0	4.0	12.0	23.0
Sligh Method (L. R. Adkins)		10.5	7.0	13.3	25.5
Vapor Temperature (550° F. end point) (L. W. Parsons)		9.2	2.2	11.3	24.2
Vapor Temperature (550° F. end point) (J. B. Hill)		9.6	...	11.5	25.0
Vapor Temperature (E. W. Dean)	437° F. end point	8.0	3.5	8.5	19.0
	475° F. end point	10.7	5.0	12.5	24.0
Vacuum Transition (H. T. Kennedy)		10.0	2.0	12.5	24.1
Bottom Temperature (H. T. Kennedy)	716° F.	8.3[a]	0.0	10.5[a]	24.6[a]
	725° F.	9.0	0.0	10.9	25.8
	734° F.	9.6	0.3	11.4	27.0
	743° F.	10.6	0.7	12.2	28.2
	752° F.	11.4	1.4	13.0	29.6
	761° F.	13.0	2.0	14.2	....
	770° F.	18.0	3.0[a]	15.5	....

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[a] Dilution closest to average of Vapor Temperature Method (460° F. end point).

Table II gives the results on the same four samples showing results at several laboratories by the steam distillation method. Most of these results are with The Standard Oil Development Co. apparatus and the average deviation is 4 per cent. Results by the other modification of the steam distillation method substantially check these and the average deviation including all results by both methods is 6.4 per cent.

General Discussion:

Table III shows a comparison of the two methods and also some special data.

Comparison of the results shows that the dilution by the steam distillation method runs appreciably higher than that by the vapor-temperature method. Since both of these methods were developed with reference to, and found valid upon, the basis of the addition of known amounts of a diluent to oils, the constant discrepancy of 3.0 per cent seems a little surprising. Comparison with the results by the vacuum transition method shows that the latter method gives results between the other two, but nearer to those by the steam distillation method. The suggestion has been made that a higher temperature than 460° F. should be chosen in the vapor temperature method, but some of the results with Sample No. 3 indicate that the use of higher temperatures does not entirely check the steam distillation method. The results by the Sligh method are of some interest; they approach those by the steam distillation method and give markedly high results on Sample No. 2.

It is believed that the discrepancy between the two methods is to be accounted for by the nature of the diluent present in used motor oils. It has already been stated that each of the methods has been found to check dilution in fresh oils when a known amount of dilution is added, this diluent representing the heavier ends of gasoline. However, it does not seem to be true that the diluent in a normal used oil is the same as the heavy ends of gasoline. Following are the results of an A.S.T.M. distillation on some diluent recovered from used crankcase oil by fire distillation:

PERCENTAGE DISTILLED OFF	TEMPERATURE, DEG. FAHR.	PERCENTAGE DISTILLED OFF	TEMPERATURE, DEG. FAHR.
Initial	253	3.0	284
10	320	28.0	356
20	344	60.0	392
30	358	88.0	500
40	370	92.0	600
50	378		
60	392		
70	406		
80	428		
90	540		
Maximum	703		

This shows that there is present in a used motor oil material which is neither gasoline nor motor oil. A part at least of the material boiling above 420° F. will be obtained by the steam distillation method while it is probably true that the 460° F. vapor-temperature method just about measures the amount of diluent which will distill off at 420° F. The question is therefore what is to be defined as dilution and it seems probable that no hard and fast definition can be given. Connected with this question is the matter of the accuracy of the method and it is apparent that with a material of indefinite composition it can hardly be anticipated that a really precise method is indicated.

Program:

The committee plans to make a further study of each of the above methods; the vapor-temperature method with particular reference to samples of heavy oil of low dilution and the steam distillation method with a view toward deciding on the most convenient form of apparatus for rapid routine work. It is felt that one or the other of these two methods can be developed for recommendation as a tentative A.S.T.M. method by next year.

Respectfully submitted on behalf of the sub-committee,

T. H. ROGERS,
Chairman.

APPENDIX

REPORT OF JOINT COMMITTEE WITH AMERICAN LEATHER CHEMISTS ASSOCIATION ON COLD TEST OF FATTY OILS

The Joint Committee with the American Leather Chemists Association was organized at the request of that organization with the object of developing a cold test or pour point method for fatty oils. The members of Sub-Committee XVI on Cloud and Pour Points of Committee D-2 have served as the A.S.T.M. representatives and the A.L.C.A. designated seven members who were interested in the work.

TABLE I.—DATA ON CLOUD AND POUR POINTS OF NEATSFOOT OIL.

	Low Cold Test Oil				High Cold Test Oil			
	Cloud Point	Deviation from Average	Pour Point	Deviation from Average	Cloud Point	Deviation from Average	Pour Point	Deviation from Average
DETERMINATIONS BY A.S.T.M. MEMBERS								
No. 1	18	−4.3	20	+0.6	26	−2.5	25	−0.6
No. 2	20	−2.3	20	+0.6	28	−0.5	25	−0.6
No. 3	26	+3.7	20	+0.6	26	−2.5	25	−0.6
No. 4	28	+5.7	15	−4.4	32	+3.5	30	+4.4
No. 5	20	−2.3	20	+0.6	28	−0.5	25	−0.6
No. 6	20	−2.3	20	+0.6	28	−0.5	25	−0.6
No. 7	24	+1.7	20	+0.6	30	+1.5	25	−0.6
No. 8	22	−0.3	20	+0.6	30	+1.5	25	−0.6
Average[a]	22.3	2.8	19.4	1.1	28.5	1.6	25.6	1.1
DETERMINATIONS BY A.L.C.A. MEMBERS								
No. 1	22	+2.6	20	+2.0	28	−0.4	20	−2
No. 2	30	+9.4	20	+2.0	40	+11.6	25	+3
No. 3	18	−2.6	20	+2.0	26	−2.4	25	+3
No. 4	20	−0.6	20	+2.0	28	−0.4	25	+3
No. 5	13	−7.6	10	−8.0	20	−8.4	15	−7
Average[a]	20.6	4.5	18	4.0	28.4	4.6	22	3.6

[a] Results from members of Sub-Committee XVI have been averaged separately because of their greater familiarity with the method. Note that pour points obtained by most of the A.L.C.A. members check closely with average results of A.S.T.M. members.

In view of the availability of the A.S.T.M. Standard Method of Test for Cloud and Pour Points of Petroleum Products (D 97 - 28),[1] it was agreed to make cooperative tests with this method on two samples of neatsfoot oil. This work was done in 1928 and a progress report was submitted showing a comparative compilation of cloud and pour point results by reporting members of the joint committee. These data are also part of this report (see Table I). The pour point results checked so closely that it seemed promising for the use of the leather chemists, but the cloud point did not prove so reliable and it was decided to do nothing further on it so far as fatty oils are concerned.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 133.

At the suggestion of the leather chemists, it was decided to check the pour points at closer intervals than that prescribed of 5° F. and in January, 1929, two new samples were sent out to members of the joint committee with instructions to determine the pour points of each, using the regular 5° F. interval of test prescribed by the A.S.T.M. Standard, and in addition to make determinations using a 2° F. interval. The results thus far received are shown in Table II. As with the two previous samples, it will be noted the figures for pour points of both samples of neatsfoot oil show a remarkably close check using the 5° F. interval and are not bad at all for the 2° F. interval. Average results show a difference of 7.5° F. between Samples Nos. 1 and 2, using the 5° F. interval, and a difference of 8° F. with the 2° F. interval, so the latter interval shows no particular advantage from the standpoint of distinguishing the samples from difference between pour points.

TABLE II.—DATA ON POUR POINT OF NEATSFOOT OIL.

	Determinations at 5° F. Intervals				Determinations at 2° F. Intervals			
	Sample No. 1	Deviation from Average	Sample No. 2	Deviation from Average	Sample No. 1	Deviation from Average	Sample No. 2	Deviation from Average
DETERMINATIONS BY A.S.T.M. MEMBERS								
No. 1	25	+1.5	35	+4	22	+0.9	30	+0.9
No. 2	20	−3.5	30	−1	20	−1.1	30	+0.9
No. 3	25	+1.5	30	−1	20	−1.1	26	−3.1
No. 4	25	+1.5	30	−1	22	+0.9	28	−1.1
No. 5	No report	...	..	..	..	...	..	...
No. 6	25	+1.5	30	−1	26	+4.9	30	+0.9
No. 7	20	−3.5	30	−1	18	−3.1	28	−1.1
No. 8	25	+1.5	35	+4	22	+0.9	32	+2.9
No. 9	25	+1.5	30	−1	24	+2.9	30	+0.9
DETERMINATIONS BY A.L.C.A. MEMBERS								
No. 1	No report	...	..	...	18	−3.1	26	−3.1
No. 2	No report	...	..	...	..	...	..	...
No. 3	25	+1.5	30	−1	20	−1.1	30	+0.9
No. 4	No report	...	..	...	..	...	..	...
No. 5	20	−3.5	30	−1	20	−1.1	30	+0.9
Average	23.5	2.1	31	1.6	21.1	2.4	29.1	1.5

Results of all tests made by the joint committee indicate that the A.S.T.M. Standard Method D 97 will give closely checking results. The method merits serious consideration by the American Leather Chemists Association as a standard method for determination of pour point of fatty oils.

Respectfully submitted on behalf of the joint committee,

RALPH R. MATTHEWS,
Chairman.

REPORT OF COMMITTEE D-4

ON

ROAD AND PAVING MATERIALS

As the result of its work during the past year, Committee D-4 offers two new specifications and recommends the revision of two existing tentative specifications and three standard specifications. It further recommends that four tentative specifications and one tentative method of test be advanced to standard and that one tentative specification and one tentative method of test be withdrawn from publication.

Upon its recommendation, as the Sectional Committee on Methods of Testing Road and Paving Materials functioning under the American Standards Association, the following three standard methods have been approved as American Tentative Standards:

> Method of Test for the Determination of Bitumen (D 4 - 27) (A.S.A. No. A 37*c*—1929);
>
> Method of Test for Penetration of Bituminous Materials (D 5 - 25) (A.S.A. No. A 37*a*—1929);
>
> Method of Float Test for Bituminous Materials (D 139 - 27) (A.S.A. No. A 37*b*—1929).

Committee D-4 has reviewed the proposed report of the Conference Committee, composed of representatives of Committees D-2 on Petroleum Products and Lubricants, D-8 on Bituminous Waterproofing and Roofing Materials and D-4, dealing with definitions of the terms bitumen, asphalt, tar, pitch and flux, and has formally approved that report.

PROPOSED REVISION OF EXISTING TENTATIVE SPECIFICATIONS

No. 1. *Tentative Specifications for Broken Stone for Waterbound Base (D 190 - 24 T).*[1]—In order to make these specifications more widely applicable without sacrifice in quality, the following revisions are recommended:

Section 4.—Change to read as follows by the addition of the italicized figure and the omission of the figure in brackets:

4. The stone shall conform to the following requirement:
Percentage of wear........................not more than [7.0] *8*.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part I, p. 902 (1924); also 1928 Book of A.S.T.M. Tentative Standards, p. 455.

Section 5.—In order to provide for use of a larger commercial size aggregate, if desired, add a third size to the first sentence to read as follows: (3) the 2½ to 4½-in. size. Also, add the following sub-section (*c*) to the table:

(*c*)	Passing 2½-in. screen....................	0 to 15 per cent
	Passing 4½-in. screen....................	95 to 100 "

It is recommended that these specifications as revised be continued as tentative.

No. 2. *Tentative Specifications for Broken Stone for Bituminous Concrete Base (D 193 – 24 T).*[1]—For reasons noted in connection with the preceding specifications the following revision is recommended:

Section 3.—Change the requirement for percentage of wear to read as follows by the addition of the italicized figure and the omission of the figure in brackets:

Percentage of wear........................not more than [6] *7.*

It is recommended that these specifications as revised be continued as tentative.

PROPOSED TENTATIVE REVISION OF EXISTING STANDARD SPECIFICATIONS

Standard Specifications for Block for Granite Block Pavements (D 59 – 26),[2] *Standard Specifications for Block for Recut Granite Block Pavements (D 131 – 23)*,[2] *Standard Specifications for Block for Durax Granite Pavements (D 132 – 23).*[2]—In order to obtain a more reliable test for percentage of wear as applied to stone block the following revision in each of these specifications is recommended for publication as tentative:

Section 3 (a).—Change to read as follows by the addition of the italicized words:

3(*a*). The percentage of wear and the French coefficient of wear shall be determined in accordance with the Standard Method of Test for Abrasion of Rock (A.S.T.M. Designation: D 2) of the American Society for Testing Materials, *except that the sample shall be prepared by use of a press and the fragments shall be as uniform and as nearly cubical as practicable.*

PROPOSED WITHDRAWAL OF EXISTING TENTATIVE SPECIFICATIONS AND METHOD OF TEST

Because the methods previously recommended for use in the testing of sand-clay and similar materials have not proved generally acceptable the committee recommends that the following tentative specifications and method of test be withdrawn from publication:

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part I, p. 908 (1924): also 1928 Book of A.S.T.M. Tentative Standards, p. 461.

[2] 1927 Book of A.S.T.M. Standards, Part II, pp. 445, 447 and 449, respectively.

1. Tentative Specifications for Natural or Artificial Sand-Clay Mixtures for Road Surfacing (D 67 - 23 T)[1];
2. Tentative Method of Test for Quantity of Clay in Sand-Clay, Topsoil and Semi-Gravel for Highway Construction (D 73 - 20 T).[2]

PROPOSED ADVANCEMENT TO STANDARD OF EXISTING TENTATIVE SPECIFICATIONS AND METHOD OF TEST

No criticisms having been received on the following tentative specifications and method of test, the committee recommends that they be advanced to standard:

1. Tentative Specifications for Sand for Sheet Asphalt and Bituminous Concrete Pavements (D 162 - 23 T);[3]
2. Tentative Specifications for Broken Stone for Water-bound Macadam Surface Course (D 191 - 24 T)[4];
3. Tentative Specifications for Broken Stone for Bituminous Macadam (D 192 - 24 T)[4];
4. Tentative Specifications for Broken Stone for Bituminous Concrete Surface (D 194 - 24 T)[4];
5. Tentative Method of Test for the Determination of Moisture Equivalent of Subgrade Soils in the Field (D 220 - 25 T)[5].

NEW SPECIFICATIONS SUBMITTED AS TENTATIVE

The following new specifications are recommended for publication as tentative:

1. Tentative Specifications for Portland-Cement Concrete for Pavements and Pavement Base.[6]
2. Tentative Specifications for Gravel for Bituminous Concrete Base, as appended hereto.[7]

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 23, Part I, p. 718 (1923); also 1928 Book of A.S.T.M. Tentative Standards, p. 466.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. XX, Part I, p. 772 (1920); also 1928 Book of A.S.T.M. Tentative Standards, p. 515.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 23, Part I, p. 717 (1923); also 1928 Book of A.S.T.M. Tentative Standards, p. 465.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 24, Part I, pp. 904, 906 and 910, respectively (1924 ; also 1928 Book of A.S.T.M. Tentative Standards, pp. 457, 459 and 463, respectively.

[5] *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part I, p. 745 (1925); also 1928 Book of A.S.T.M. Tentative Standards, p. 517.

[6] These specifications were published as information in Appendix II to the 1928 Report of Committee D-4, see *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 530 (1928). The recommendation to accept these specifications as tentative was rejected at the annual meeting, see Summary of Proceedings, p. 32.

[7] See p. 702.

The proposed Tentative Specifications for Portland-Cement Concrete for Pavements and Pavement Base were prepared in view of the wide use of concrete for pavements and bases, for it was felt that the Society should have a specification governing the quality of concrete for this purpose. The specifications are very wide in scope in that they involve a range of matters concerned with concrete. Obviously, it is impracticable to include data in support of all of the various portions of the specification. These portions have been built up from time to time as the result of data and discussion not only in this Society but in the committees of other organizations such as those of the American Concrete Institute and the American Association of State Highway Officials.

TABLE I.—ANALYSIS OF LETTER BALLOT VOTE.

Items	Affirmative	Negative	Not Voting
I. PROPOSED NEW TENTATIVE STANDARDS			
Tentative Specifications for Portland Cement Concrete for Pavements and Bases[a]	42	5	36
Tentative Specifications for Gravel for Bituminous Concrete Base	46	0	37
II. PROPOSED TENTATIVE REVISIONS OF EXISTING STANDARDS			
Standard Specifications for Block for Granite Block Pavements (D 59 - 26)	43	1	39
Standard Specifications for Block for Recut Granite Block Pavements (D 131 - 23)	43	1	39
Standard Specifications for Block for Durax Granite Pavements (D 132 - 23)	42	1	40
III. PROPOSED REVISIONS OF EXISTING TENTATIVE STANDARDS			
Tentative Specifications for Broken Stone for Waterbound Base (D 190 - 24 T)	50	0	33
Tentative Specifications for Broken Stone for Bituminous Concrete Base (D 193 - 24 T)	49	2	32
IV. PROPOSED ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
Tentative Specifications for Sand for Sheet Asphalt and Bituminous Concrete Pavements (D 162 - 23 T)	50	1	32
Tentative Specifications for Broken Stone for Waterbound Macadam Surface Course (D 191 - 24 T)	51	0	32
Tentative Specifications for Broken Stone for Bituminous Macadam (D 192 - 24 T)	51	0	32
Tentative Specifications for Broken Stone for Bituminous Concrete Surface (D 194 - 24 T)	51	0	32
Tentative Method of Test for the Determination of Moisture Equivalent of Subgrade Soils in the Field (D 220 - 25 T)	41	0	42
V. PROPOSED WITHDRAWAL OF EXISTING TENTATIVE STANDARDS			
Tentative Specifications for Natural or Artificial Sand-Clay Mixtures for Road Surfacing (D 67 - 23 T)	49	0	34
Tentative Method of Test for Quantity of Clay in Sand-Clay, Topsoil and Semi-Gravel for Highway Construction (D 73 - 20 T)	49	0	34

[a] The classified vote on the Tentative Specifications for Portland Cement Concrete for Pavements and Bases was as follows: Affirmative, 17 Producers, 12 Consumers, 13 General Interests; Negative, 3 Producers, 2 Consumers; not voting, 22 Producers, 9 Consumers, 5 General Interests.

About a year ago attention was directed to the fact that although gravel is used in bituminous road construction, no specifications pertaining to it had been issued by the Society, whereas stone and slag are covered by standard or tentative specifications. Accordingly, the Specifications for Gravel for Bituminous Concrete Base were drawn up patterned in form after those for Broken Slag for Bituminous Concrete Base (D 196 - 27), and in grading similar to that recommended by the Federal Specifications Board for Broken Stone and

Broken Slag for Bituminous Concrete Base and Surface Course. Requirements for quality are as nearly as feasible like those proposed for coarse aggregate for portland-cement concrete pavements.

The committee has received several criticisms of the Tentative Method of Test for Residue of Specified Penetration (D 243 - 28) and has planned to revise the description and specifications for apparatus with a view to including apparatus more generally acceptable to the industry and consumers of oil throughout the country.

The results of the letter ballot of the committee upon the recommendations made in this report appear in Table I.

This report has been submitted to letter ballot of the committee, which consists of 83 members; 62 members returned their ballots, of whom 58 have voted affirmatively and 4 negatively.

Respectfully submitted on behalf of the committee,

R. W. CRUM,
Chairman.

PRÉVOST HUBBARD,
Secretary.

EDITORIAL NOTE

The proposed Tentative Specifications for Gravel for Bituminous Concrete Base were accepted for publication as tentative and appear on page 702.

The recommendation that the proposed Specifications for Portland-Cement Concrete for Pavements and Pavement Base be accepted for publication as tentative was rejected at the annual meeting.

The proposed tentative revisions of the Standard Specifications for Block for Granite Block Pavements; for Block for Recut Granite Block Pavements; and for Block for Durax Granite Pavements were accepted for publication as tentative and appear on page 867.

The proposed revisions of the Tentative Specifications for Broken Stone for Waterbound Base, and for Broken Stone for Bituminous Concrete Base were accepted. The tentative specifications in their revised form appear on pages 704 and 706, respectively.

The Tentative Specifications for Sand for Sheet Asphalt and Bituminous Concrete Pavements; for Broken Stone for Waterbound Macadam Surface Course; for Broken Stone for Bituminous Macadam; and for Broken Stone for Bituminous Concrete Surface, and the Tentative Method of Test for the Determination of Moisture Equivalent of Subgrade Soils in the Field were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 150, 151, 153, 155 and 211, respectively.

The withdrawal of the Tentative Specifications for Natural or Artificial Sand-Clay Mixtures for Road Surfacing and the Tentative Method of Test for Quantity of Clay in Sand-Clay, Topsoil and Semi-Gravel for Highway Construction was approved.

DISCUSSION

[Mr. R. W. Crum, in presenting the report of Committee D-4, recommended the acceptance as tentative of the Specifications for Portland Cement Concrete for Pavements and for Pavement Base. —Ed.]

Mr. J. S. Miller, Jr.[1]—Not until I heard the results of the letter ballot upon these specifications and discussed with some of those who voted negatively did I realize—and I think a great many others are in the same position—just what is meant by these new specifications.

Those of us who are not in such close touch with concrete construction can interpret what character of mix is meant by a requirement in a mix for a base for a pavement having a modulus of rupture of not less than 500 lb. per sq. in. I should like to ask whether we could have an idea of what mix this represents in the usual terms as to the cement ratio to fine and coarse aggregates. In other words, are we changing the strength of bases for pavements and making them stronger, and unnecessarily stronger? While I voted affirmatively on these tentative specifications, my vote would be changed dependent upon the answer to that question.

Mr. R. W. Crum[2] (*Chairman, Committee D-4*).—I do not have in mind any statement of proportions upon which this requirement was based by the sub-committee. The requirement of 600 lb. per sq. in. modulus of rupture for concrete pavement is in accord with present practice. Lower strength concrete for bases is indicated by the requirement of 500 lb. per sq. in. modulus of rupture.

Mr. Prévost Hubbard.[3]—There is 100 lb. per sq. in. difference.

Mr. Miller.—What I am getting at is, does the 500 lb. per sq. in. minimum modulus of rupture represent a 1:3:6 or a 1:2:4 mix?

Mr. Crum.—I do not know just what the sub-committee figured.

Mr. Hubbard.—I am unable to answer the question from personal calculations, but being a member interested in the laying of bituminous pavements on concrete bases, I had one of our engineers make some calculations, and he figured that in general concrete with a minimum modulus of rupture of 500 lb. per sq. in., would be a richer mixture than 1:3:6, which has been customarily used as a foundation mixture for bituminous pavements. I was one of the members who voted negatively on this proposition largely for that reason, because we are firmly convinced that the use of a strong base which will necessarily have a relatively high tensile strength is not beneficial to a bituminous top which is laid over it. In other words, the concrete with a high tensile strength will develop contraction cracks at less frequent intervals than a leaner mixture, and these cracks are, therefore, apt to be wider and almost invariably carried through the wearing surface, whereas in a leaner mixture the cracks occur at more frequent intervals, are not so wide and are not carried through the wearing surface. For that reason largely we prefer the lean mix concrete for base.

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[1] Director, Technical Bureau, The Barber Asphalt Co., Maurer, N. J.

[2] Director, Highway Research Board, National Research Council, Washington, D. C.

[3] Chemical Engineer, The Asphalt Assn., New York City.

MR. A. W. DOW.[1]—Mr. Chairman and Members: I cannot agree entirely with Mr. Hubbard. I do not believe the strength of concrete is so much responsible for its cracking as its density. It seems to be invariably the case that when we have a dense concrete base under asphalt pavements, the concrete cracks badly. These cracks usually show up through the asphalt wearing surface in the course of time, thus making an ugly appearing pavement even though it does not grind away as does a cracked concrete surface. From my observation a leaner concrete base cracks far less than a dense one. This is well recognized by engineers who have had long experience in concrete. I find that concrete bases as made nowadays in many cases are a mixture of 1:2:5, and that they crack abnormally. A mixture of 1:3:6 is better but this also cracks under certain conditions. This subject should be thoroughly studied. It appears to me from a theoretical standpoint that a less dense concrete would crack less because of the voids it contains allowing the concrete to yield to its internal expansion. This however, is only a surmise and the subject should be given a thorough study as these foundations are doing great damage to asphalt pavements.

MR. MILLER.—It seems to me that in view of this difference of opinion that has been brought out subsequent to a letter ballot, serious consideration should be given to these specifications before accepting them as tentative. I dislike very much to upset anything the committee has done and carried through to this point, but it is a serious matter to have specifications published as tentative that are so at variance with previous practice. We are having troubles enough with cracks in foundations showing through the wearing surface. We certainly do not want to increase that trouble, and I should like to see this recommendation defeated.

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[1] Member of Firm, Dow & Smith, Paving and Chemical Engineers, New York City.

MR. CRUM.—These specifications were printed a year ago as information and until they came up for consideration this year, practically no adverse comments had been received. Therefore, the committee recommended their acceptance for publication as Tentative, with the letter ballot resulting as reported.

[The motion to accept the specifications for publication as tentative was put to vote and lost by a vote of 1 affirmative and 8 negative. —ED.]

REPORT OF COMMITTEE D-5
ON
COAL AND COKE

Committee D-5 held one meeting during the past year at Chicago, Ill., on March 21, and another will be held at the annual meeting of the Society prior to the presentation of this report.

A new Sub-Committee on Foundry Coke Specifications has been formed to review the Standard Specifications for Foundry Coke (D 17 - 26) with the object of revising these specifications. The American Foundrymen's Association is represented on this new sub-committee. A new sub-committee on coke sampling has been formed to develop standard methods for collecting coke samples. An Advisory Sub-Committee was also formed during the past year.

Sub-Committee I on Methods of Testing (A. C. Fieldner, chairman).—This sub-committee, in cooperation with Sub-Committee IV on Standard Sizes, has prepared a Method of Test for Size of Anthracite which is now being presented to the Society as a tentative method.[1]

The sub-committee recommends that the Tentative Method of Test for Fineness of Powdered Coal (D 197 - 26 T) be continued as tentative, as it expects to improve the method of collecting representative samples from unit powdered-coal systems.

Sub-Committee II on Nomenclature and Definitions (H. C. Porter, chairman).—This sub-committee has under consideration revisions in the Tentative Definitions of Terms Relating to Coal and Coke (D 121 - 27 T) and recommends that they be continued as tentative for another year.

Sub-Committee IV on Standard Sizes (J. H. McNally, chairman).—This sub-committee, in conjunction with Sub-Committee I, developed a Method of Test for Size of Anthracite, as appended hereto,[1] which is now being presented for publication as tentative. This sub-committee has now completed the work assigned to it and is accordingly being discontinued.

Sub-Committee V on Tolerances (W. B. Calkins, chairman).—This sub-committee is continuing cooperative sampling experiments to determine permissible tolerances in collecting duplicate samples of coal.

Sub-Committee VII on Pulverizing Characteristics of Coal (John Van Brunt, chairman).—This sub-committee is conducting laboratory experiments on methods to determine comparative pulverizing characteristics of different coals in connection with their commercial pulverization for use as powdered fuel.

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[1] See p. 708.—Ed.

RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS

Proposed New Tentative Standards:

Proposed Tentative Method of Test for Size of Anthracite.—This method of test was prepared jointly by Sub-Committee IV on Standard Sizes and Sub-Committee I on Methods of Testing. It was approved by Committee D-5 at a meeting held at Atlantic City, June 25, 1928, and was subsequently published by the Society as information as mentioned in the September, 1928, issue of the A.S.T.M. Bulletin. Committee D-5 recommends that the new method of test, appended hereto,[1] be accepted for publication as tentative.

Proposed Tentative Method of Test for Sieve Analysis of Crushed Bituminous Coal.—This method was prepared by Sub-Committee I on Methods of Testing and approved by Committee D-5 at a meeting held at Atlantic City, June 25, 1928. The method was subsequently published by the Society as information as mentioned in the September, 1928, issue of the A.S.T.M. Bulletin. It is recommended that this method be accepted for publication as tentative with the addition to the method as previously printed of a new section on scope and a change in the sieve tolerances. The methods are appended hereto[2] in their proposed revised form.

Proposed Tentative Revisions of Standards:

Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 - 27).[3]—It is recommended that the following revisions in these methods be accepted for publication as a tentative revision:

Section 15.—Under Method *B* using Meker Burner for determination of volatile matter, the temperature may be indicated by the fusion of pure K_2CrO_4 in the covered crucible. It is stated in the fourth sentence that the fusion point of pure K_2CrO_4 is 940° C. This temperature was taken from determinations made by Le Chatelier and published in 1894. Later determinations show that the temperature given is too low. Recent determinations made by Smith and Hartgen[4] of the U. S. Bureau of Mines show that the melting point of pure K_2CrO_4 is 968° C. It is recommended that the temperature for fusion of K_2CrO_4 be changed from "940° C." to read "968° C.," with the following footnote:

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[1] See p. 708.—ED.

[2] See p. 711.—ED.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 535.

[4] D. F. Smith and F. A. Hartgen, "The Melting Point of Potassium Chromate" U. S. Bureau of Mines, *Reports of Investigations*, Serial No. 2917 (1929).

U. S. Bureau of Mines *Reports of Investigations,* Serial No. 2917 (1929).

Section 20.—The present temperature (870–925° C.) given for ignition of coal and coke with Eschka mixture in the determination of sulfur is unnecessarily high and if porcelain crucibles are used they are short lived due to the action of the Eschka mixture on the crucibles at this temperature. Experiments have been made with different coals and cokes to show that lower temperatures give accurate results. Committee D-5 accordingly recommends revisions in Paragraphs (*c*) and (*d*) of this section, as follows:

Change Paragraph (*c*) to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

(*c*) (For coal).—Place the crucible in a cold muffle and gradually raise the temperature to [870–925° C. (cherry-red heat)] *800° C. ± 25° C.* in about 1 hour. Maintain [the] *this* maximum temperature for about 1½ hours [and then allow the crucible to cool in the muffle].

Change Paragraph (*d*) to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

(*d*) (For coke).—Place the crucible in a warm muffle and gradually raise the temperature to [870–925° C. (cherry-red heat)] *800° C. ± 25 C.* in about 30 minutes. Maintain this maximum temperature until on stirring all black particles have disappeared.

Section 36 (*a*).—Change the last sentence to read as follows by the addition of the italicized words:

The bomb shall have an inner surface *and accessory fittings, including crucible,* of platinum, gold, porcelain enamel, or other material which is not attacked by HNO_3 and H_2SO_4, or other products of combustion.

Advancement of Tentative Standards to Standard:

The committee recommends the advancement to standard of the following four tentative methods with revisions as indicated:

1. *Tentative Method of Test for Cubic Foot Weight of Crushed Bituminous Coal* (*D 291 – 28 T*).[1]—Add the following paragraph on Scope as a new Section 1, renumbering the subsequent sections accordingly:

1. *Scope.*—This method is intended for the rather coarsely crushed coal, less than 1½ in. in size, such as is charged into coke ovens. It does not apply to powdered coal as used in boiler plants.

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[1] *Proceedings,* Am. Soc. Testing Mats., Vol. 28, Part I, p. 966 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 554.

2. *Tentative Method of Test for Cubic Foot Weight of Coke (D 292 - 28 T).*[1]—Add the following paragraph on Scope as a new Section 1, renumbering the subsequent sections accordingly:

> 1. *Scope.*—The method for cubic foot weight of coke is intended for coke 5 in. and smaller, that is, coke which would in any position pass through a 5-in. square-mesh sieve.

3. *Tentative Method of Test for Sieve Analysis of Coke (D 293 - 28 T):*[2]

Section 1.—Change the second sentence from its present form: namely,

> In accordance with the Standard Specifications for Sieves for Testing Purposes (Serial Designation: E 11) of the American Society for Testing Materials a tolerance of ± 3 per cent on average openings and of 10 per cent in maximum openings are permissible.

to read as follows:

> Tolerances of ± 5 per cent on average openings and of 15 per cent in maximum openings are permissible.[a]

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[a] For methods of testing sieves see the Standard Specifications for Sieves for Testing Purposes (A.S.T.M. Designation: E 11), 1927 Book of A.S.T.M. Standards, Part II, p. 917.

4. *Tentative Method of Tumbler Test for Coke (D 294 - 28 T):*[3] *Section 2.*—Change the third sentence from its present form: namely,

> In accordance with the Standard Specifications for Sieves for Testing Purposes (Serial Designation: E 11) of the American Society for Testing Materials a tolerance of ± 3 per cent on average openings and of 10 per cent in maximum openings are permissible.

to read as follows:

> Tolerances of ± 5 per cent on average openings and of 15 per cent in maximum openings are permissible.[a]

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[a] For methods of testing sieves see the Standard Specifications for Sieves for Testing Purposes (A.S.T.M. Designation: E 11), 1927 Book of A.S.T.M. Standards, Part II, p. 917.

Advancement to Standard of Tentative Revisions of Standards:

Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 - 27).[4]—The tentative revisions in these standard methods published last year[5] consisted of the following:

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[1] *Proceedings,* Am. Soc. Testing Mats., Vol. 28, Part I, p. 968 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 556.

[2] *Proceedings,* Am. Soc. Testing Mats., Vol. 28, Part I, p. 970 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 558.

[3] *Proceedings,* Am. Soc. Testing Mats., Vol. 28, Part I, p. 973 (1928); also 1928 Book of A.S.T.M. Tentative Standards. p. 561.

[4] 1927 Book of A.S.T.M. Standards, Part II, p. 535.

[5] *Proceedings,* Am. Soc. Testing Mats., Vol. 28. Part I, p. 1129 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 861.

(*a*) A revision in the form of separate tentative methods entitled "Methods for the Determination of Sulfur in Coal and Coke by the Bomb-Washing and Sodium Peroxide Fusion Methods (D 271 – 27 T)"[1] intended to be added to the present standard methods as an alternate method with the present Eschka method.

(*b*) A revision in the procedure for determination of phosphorus in the ash of coal and coke described in Sections 21 and 22 of the Standard Methods D 271 – 27.

The committee recommends that these tentative revisions be adopted as standard, with the following change in the Sodium Peroxide Fusion Method of the Tentative Methods D 271 – 27 T:

Add the following sentence after the first sentence in the second paragraph under Method:

> Place the bomb inside a piece of steel pipe when the charge is ignited to prevent possible injury to the operator if the bomb should burst.

The above recommendations have been submitted to letter ballot of the committee with the following results:

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARDS			
Tentative Method of Test for Size of Anthracite	39	0	3
Tentative Method of Test for Sieve Analysis of Crushed Bituminous Coal	42	0	0
II. TENTATIVE REVISIONS OF STANDARDS			
Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 – 27)	34	0	8
III. ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
Tentative Method of Test for Cubic Foot Weight of Crushed Bituminous Coal (D 291 – 28 T) as revised	38	0	4
Tentative Method of Test for Cubic Foot Weight of Coke (D 292 – 28 T) as revised	38	0	4
Tentative Method of Test for Sieve Analysis of Coke (D 293 – 28 T) as revised	37	1	4
Tentative Method of Tumbler Test for Coke (D 294 – 28 T) as revised	35	0	7
IV. ADVANCEMENT TO STANDARD OF TENTATIVE REVISIONS OF STANDARDS			
Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 – 27)	39	0	3

This report has been submitted to letter ballot of the committee, which consists of 48 members; 42 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

W. A. SELVIG,
Secretary.

A. C. FIELDNER,
Chairman.

H. C. PORTER,
Vice-Chairman.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 959 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 551.

EDITORIAL NOTE

The proposed Tentative Methods of Test for Size of Anthracite, and Test for Sieve Analysis of Crushed Bituminous Coal were accepted for publication as tentative and appear on pages 708 and 711, respectively.

The proposed tentative revision of the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke was accepted for publication as tentative and appears on page 871.

The tentative revisions of the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke were approved at the annual meeting and subsequently adopted as standard by letter ballot vote of the Society on September 3, 1929. The standard methods in their revised form appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 212.

The Tentative Methods of Test for Cubic Foot Weight of Crushed Bituminous Coal; Test for Cubic Foot Weight of Coke; Test for Sieve Analysis of Coke, and Tumbler Test for Coke, as revised, were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 250, 252, 254 and 257, respectively.

REPORT OF SECTIONAL COMMITTEE ON THE CLASSIFICATION OF COAL

INTRODUCTION

A little more than two years ago a meeting of representatives of various professional societies and of industrial, educational, and governmental organizations was held in Pittsburgh to consider what action, if any, should be taken on the classification of North American coals. This meeting was called by the American Standards Association (then the American Engineering Standards Committee) because a system for the use classification of coal, proposed by G. H. Ashley,[1] had been referred to the Association by the Coal Mining Institute of America. The meeting was well attended and was definitely in favor of taking up the whole question of both scientific and use classification of coals, including all the various ranks from lignite to anthracite. The American Society for Testing Materials was recommended as the sponsor organization to take charge of the work and organize the sectional committee, according to the rules of the American Standards Association. These rules provide that: "The personnel and composition of each sectional committee shall be authoritative and adequately representative of the various interests concerned in the standard or group of standards for the formulation of which the sectional committee is responsible."

Following this meeting the American Society for Testing Materials proceeded with the organization of the committee. Invitations to appoint representatives were sent to the various trade organizations interested in the production, distribution, and consumption of coal, and also to professional, scientific and technical societies and to governmental organizations interested in coal classification. The organization meeting of the committee was held in Philadelphia on June 10, 1927. Officers were elected, regulations adopted, and general plans for carrying out the work were outlined.

Following this organization meeting, the membership of the sectional committee was completed. The total membership of 28 consisted of 8 producers, 2 distributors, 9 consumers, and 9 members representing general and scientific interests.

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[1] G. H. Ashley, "A Practical Classification of Coals," *Proceedings*, Coal Mining Inst. of America, pp. 29–36 (1923); also "A Use Classification of Coal," *Transactions*, Am. Inst. Mining and Metallurgical Engrs., Vol. 63, pp. 782–796 (1920).

Obviously, a committee of 28 members is too large for effective operation. Therefore, three technical committees of 10 to 12 members each were organized; the first on Scientific Classification, H. J. Rose, chairman; the second on Use Classification, W. H. Fulweiler, chairman; and the third on Marketing Practice, F. R. Wadleigh, chairman. The Technical Committee on Scientific Classification was requested to formulate a system of coal classification based on the chemical and physical properties of the coal and with reference to origin and constitution. The Technical Committee on Use Classification was charged with developing a system of classification, if possible, based primarily on the uses of coal and commercial practice—this system to be correlated with the scientific system in so far as possible and desirable. The Technical Committee on Marketing Practice was formed to collect and collate information on commercial practice for the benefit of the other two technical committees.

The first meetings of the technical committees were held on November 17, 1927, and the first informal progress reports were submitted to the sectional committee at the annual meeting held on March 29, 1928. Technical committee meetings have since been held on November 19, 1928, and March 28, 1929, the latter being the second annual meeting of the sectional committee. Reports presented at these meetings showed that a satisfactory beginning had been made in planning programs and assembling necessary data for carrying out the work. A brief review of the work to date is here presented.

Work of the Technical Committee on Scientific Classification:

The Technical Committee on Scientific Classification agreed that a scientific system for the classification of coal should be developed primarily on the basis of chemical, physical, and geological considerations. The work of the committee was organized under the following sub-committees:

Sub-Committee I on Nature, Location, and Mode of Occurrence of Types of American Coals, M. R. Campbell, chairman.

Sub-Committee II on Methods of Analysis, Origin and Composition of Coal, A. C. Fieldner, chairman.

Sub-Committee III on Present and Proposed Systems of Coal Classification, H. J. Rose, chairman.

Mr. M. R. Campbell,[1] chairman of Sub-Committee I, presented a comprehensive description of the U. S. Geological Survey basis of classification of coal by ranks at the first international conference in 1926. This system of classification by rank recognizes the various stages through which coaly matter passes in its progressive transformation from peat to anthracite. Unfortunately, nature has not set up any definite subdivisions in this scale; therefore, the limits of the different ranks are arbitrary, and overlapping of properties cannot be avoided. However, Mr. Campbell has given extended study to this scheme of classification and has developed a general plan of classification which has been used by the U. S. Geological Survey and the U. S. Bureau of Mines for coals of the United States. This scale includes the following nine classes or ranks of coal and allied mineral substances:

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[1] Marius R. Campbell, "American Coal Supply: Its Quantity, Quality, and Distribution," *Proceedings*, International Conference on Bituminous Coal, Carnegie Inst. of Tech., pp. 5–64 (1926).

CLASS OR RANK	EQUIVALENT TERM IN PRESENT U. S. GEOLOGICAL SURVEY CLASSIFICATION
A	Peat
B	Lignite
C	Sub-bituminous
D	Bituminous, low rank
E	Bituminous, high rank
F	Semi-bituminous
G	Semi-anthracite
H	Anthracite
I	Super-anthracite

The application of chemical and physical criteria to these classes will require extended work by the sub-committee. Proximate and ultimate analyses, calorific values, and physical properties are all of importance. For a beginning, Mr. Campbell has confined himself to the proximate analysis and the calorific value of the dry, ash-free coal, and to certain physical properties, such as the tendency to slack on exposure to the atmosphere. Table I gives a summary of these criteria.

These criteria of classes of coal in the rank scale apply to the ordinary ulmic or woody type of coals. Similar criteria will be worked out for cannel and boghead coals. Three types of coal are recognized, namely, (1) woody, xyloid, ulmic, or humic coals; (2) canneloid or spore coals; and (3) boghead or algal coals. The type represents the nature of the original coal-forming vegetation, and the rank represents the degree of transformation or metamorphism.

Sub-Committee II on Methods of Analysis, Origin and Composition of Coal is the authority on testing methods, both in describing existing methods and in developing new methods. This sub-committee is the source of information on the interpretation of old analyses, and of advice on existing analytical methods and the development of new testing methods. Existing analytical data are being assembled by this sub-committee. A preliminary report has been made which gives the probable errors and limits of accuracy of the Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (D 271 - 27) of the American Society for Testing Materials.[1] The sub-committee also reports on the effect of changes made from time to time in the Standard Methods D 271.

Experiments are now in progress on the development of an accelerated slacking test for low-rank coals and lignites. These coals usually have a high moisture content and disintegrate or slack after mining. The slacking tendency has been considered characteristic of sub-bituminous coals and lignite in the U. S. Geological Survey method of classification.

TABLE I.—ANALYTICAL LIMITS AND PHYSICAL CRITERIA FOR VARIOUS RANKS OF COAL.

Class or Rank	Proximate Analysis, Percentage in Ash-free Coal			Calorific Value of Ash-free Coal, B.t.u.	Physical Properties and Occurrence
	Moisture	Volatile Matter	Fixed Carbon		
A......	90 to 80	....	....	....	Peat.
B......	50 to 32	25 to 30	28 to 37	6 400 to 8 300	Slacks freely on weathering: non-coking; northern part of Great Plains and Gulf Coastal area.
C......	32 to 12	32 to 38	36 to 50	8 550 to 11 800	Slacks considerably on weathering: non-coking; western states and possibly certain coal fields of Iowa, Illinois, Missouri, western Kentucky, and Indiana.
D......	12 to 5	39 to 42	49 to 53	12 000 to 13 600	Slight or no slacking on weathering; may be coking; all coal-bearing states except the Dakotas.
E	5 to 3.5	40 to 22	55 to 75	14 000 to 15 000	No slacking properties: often coking; most abundant in Appalachian field, but also found in most coal-bearing states.
F......	2.6 to 2.3	23 to 15	74 to 82	15 200 to 15 300	Friable; coking; nearly smokeless; central Pennsylvania, New River—Pocahontas field, Fort Smith field of Arkansas and Oklahoma.
G......	Fuel ratio (fixed carbon to volatile matter) from 4.0 to 10.0..................................				Less hard and less lustrous than typical anthracite; near Lykens, Bernice, and Carbondale in Pennsylvania; Meadow Branch field of West Virginia; and Valley field of Virginia.
H......	All Pennsylvania anthracite with fuel ratio (fixed carbon to volatile matter) over 10.0...				Pennsylvania anthracite.
I..					Resembles graphite; Rhode Island and southern Massachusetts; local deposits due to metamorphism caused by volcanic dikes and sills.

Briefly, the slacking test consists of air-drying a 1000-g. sample of 1 to 2-in. lumps at 30 to 35° C. for 24 hours, and then immersing the lumps in water for one hour; the water is then drained off, and the sample is again air-dried for 24 hours. The amount of disintegration is determined by sieving on an 8-in. wire-mesh sieve with $\frac{1}{4}$-in. square openings, and weighing the undersize and oversize. The percentage of undersize is a measure of the slacking characteristics of the coal. Results of preliminary tests are promising; a sample of Texas lignite gave 97 per cent fines; a Wyoming sub-bituminous coal, 84 per cent; an Iowa low-rank bituminous, 24 per cent; and high-rank bituminous coals, which are known not to slack, gave 3 to 10 per cent fines.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 535.

One of the most important problems facing the analytical sub-committee is the question of whether to use for classification the simple, dry, ash-free analytical values as ordinarily determined in commercial coal analyses, or the "unit" values as proposed by S. W. Parr. Strict accuracy also demands special correction of the hydrogen and carbon determinations to eliminate that part of these elements which is derived from water of constitution in shale or clay and from carbonates. F. V. Tideswell and R. V. Wheeler,[1] and C. A. Seyler[2] favor such corrections. The committee recognizes the theoretical justification in their favor, but it also appreciates the practical difficulties of getting commercial laboratories to adopt the more complicated procedures. The committee is therefore approaching this question with an open mind, and proposes to make a thorough investigation of the problem.

The U. S. Bureau of Mines is now studying the various methods for correcting the ash of coal back to the original mineral matter. The suggestion has been made that the inorganic matter be removed in so far as possible by a float-and-sink process, oil flotation, or acid extraction, before making the chemical analysis, thus avoiding the necessity for correcting the analyses for the errors introduced by high ash content. Such a procedure should reduce the ash content to an amount so low that the error could be disregarded for classification purposes. The committee has received the cooperation of H. G. Turner, of Lehigh University, in studying the removal of ash by acid extraction. Experimental work is now in progress.

Sub-Committee III on Present and Proposed Systems of Classification is making an exhaustive study of the more important methods proposed for coal classification, with the object of correlating coals in each of the principal systems of classification.

Almost all scientific systems of classification are based on either proximate or ultimate analysis of the coal or on a combination of proximate analysis and calorific value. The principal systems under consideration by the sub-committee are the following:

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[1] F. V. Tideswell and R. V. Wheeler, "Pure Coal as a Basis for Classification," *Technical Publication 104*, Am. Inst. Mining and Metallurgical Engrs., March, 1928.

[2] Clarence A. Seyler, "The Classification of Coal," paper presented at New York meeting, Am. Inst. Mining and Metallurgical Engrs., February, 1928.

1. On the basis of proximate analysis, calorific value, and physical characteristics. U. S. Geological Survey[1] and Ashley systems.[2]

2. On the basis of "unit coal" volatile matter and calorific value. The Parr system.[3]

3. On the basis of ultimate analysis. The Seyler[4] and Ralston[5] systems of plotting carbon, hydrogen and oxygen on a tri-axial diagram.

4. On the basis of physical and burning characteristics. The German or Continental European system.

This sub-committee is now engaged in correlating these various classification systems[6] and in developing graphic methods for comparing them. It is evident that the ultimate analysis systems of Seyler and Ralston and the Parr system can be correlated in this manner; likewise the proximate analysis methods such as that of the U. S. Geological Survey and the one proposed by Ashley can be compared to the others, perhaps less directly, but nevertheless with sufficient accuracy to permit the setting up of limits for those groups of coals which have similar characteristics, so that each coal may be placed in any system. From these comparisons the sub-committee hopes to work out eventually the best combination of analytical and other criteria for a scientific classification of coal.

Work of the Technical Committee on Use Classification:

The Technical Committee on the Use Classification of coal is charged with making a study of the possibilities in the development of such a classification if desirable, possible, and equitable, based principally on the uses of coal and commercial practice, but also correlated with scientific classification in so far as is thought desirable or possible. One of the objectives of this committee is to determine how far the scientific classification may be of use in commercial practice. Another objective is to secure data on the different uses for coal and the requirements for these uses. To attain this end, sub-committees were appointed to obtain data on the following uses and types of coal:

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[1] M. R. Campbell, *Professional Paper 100 A*, U. S. Geological Survey, 1917–1922; also *Proceedings*, International Conference on Bituminous Coal, Carnegie Inst. of Tech., pp. 11–16 (1926).

[2] G. H. Ashley, "A Practical Classification of Coals," *Proceedings*, Coal Mining Inst. of America, pp. 29–36 (1923); also "A Use Classification of Coal," *Transactions*, Am. Inst. Mining and Metallurgical Engrs., Vol. 63, pp. 782–796 (1920).

[3] S. W. Parr, "The Classification of Coal," *Journal of Industrial and Engineering Chemistry*, Vol. 14, p. 919 (1922).

[4] Clarence A. Seyler, *Proceedings*, South Wales Inst. of Engrs., Vol. 21, p. 483, et seq. (1900); represented in Fuel in Science and Practice, 1924, Vol. 3, pp. 15–26, 41–49, and 79–83 (1924).

[5] O. C. Ralston, "Graphic Studies of Ultimate Analyses of Coals," *Technical Paper No. 93*, U. S. Bureau of Mines (1915).

[6] For a fuller discussion of these systems of classification, see A. C. Fieldner, "The Classification of North American Coals," U. S. Bureau of Mines *Circular No. 6094;* also *Proceedings*, Second International Conference on Bituminous Coals, Carnegie Inst. of Tech., Vol. 1, p. 632 (1928).

Sub-Committee I on Coal Used in Gas Making: Water Gas, Coal Gas, and Producer Gas.
Sub-Committee II on Coal Used in Coke Making.
Sub-Committee III on Coal Used in the Brick and Tile Industries.
Sub-Committee IV on Coal Used in the Cement Industry.
Sub-Committee V on Coal Used in the Metallurgical Industry.
Sub-Committee VI on Smithing Coal.
Sub-Committee VII on Railroad Coal.
Sub-Committee VIII on Coal Used in Stationary Steam Generation.
Sub-Committee IX on Domestic Bituminous Coal.
Sub-Committee X on Domestic Anthracite Coal.

Considerable information has been assembled by the sub-committee on gas coals, coal for water-gas generators, and coal for producer gas. Specifications and desirable characteristics for these classes of coal are outlined in the first report of this sub-committee.

The sub-committee on coals for stationary steam generation also has submitted a comprehensive preliminary report on the desirable characteristics of coals for hand firing, for different types of stokers used in steam power plants, and for pulverized fuel combustion. Obviously, no hard and fast rules can be laid down for such coals, since costs and available supply are important factors.

The task before the use classification committee is a large one, and several years will be required to assemble all the needed information.

Work of the Technical Committee on Marketing Practice:

The Technical Committee on Marketing Practice is to collect and correlate information on marketing practice with reference to classification, and for the benefit of the other two technical committees. In order to collect data on marketing practice and classifications now in use, sub-committees were appointed to cover the various marketing areas of the country. These sub-committees are as follows:

Sub-Committee I on Anthracite (all markets).
Sub-Committee II on New England Region.
Sub-Committee III on Coastwise (tidewater), export and bunkers, and Atlantic states inland.
Sub-Committee IV on Northern United States.

Sub-Committee V on Southern United States.
Sub-Committee VI on Southwestern United States.
Sub-Committee VII on Rocky Mountain Region.
Sub-Committee VIII on Pacific Coast.
Sub-Committee IX on Central United States (east of Mississippi River).
Sub-Committee X on Southern inland United States.
Sub-Committee XI on Great Lakes and Northwest United States.
Sub-Committee XII on Canada, eastern and central.
Sub-Committee XIII on Canada, western.

Of these sub-committees, four have already completed comprehensive reports, namely, those on anthracite, the Pacific coast, the southern inland, and the Rocky Mountains region. The data being obtained are proving to be particularly valuable to the use classification committee.

Summary and Conclusions:

In summarizing the program of the sectional committee the following important considerations are being kept in mind:

1. Coal should be classified primarily on the basis of its intrinsic chemical and physical properties. These properties involve the origin, composition, and constitution of the coal.
2. Use classification should be secondary to scientific classification and should be correlated with the scientific classification as far as possible.
3. Scientific classification depends on two primary factors: First, the composition and type of the original coal-forming vegetation, and second, the degree of metamorphism or coalification of the vegetable residue.
4. The first factor is described broadly in the type of the coal, as xyloid, canneloid, or boghead; the second factor, in the progressive rank of the coal as expressed in the series from lignite to anthracite.
5. The criteria to be considered for classifying under these two general factors are proximate and ultimate analyses, calorific values, microscopic examination, extraction with solvents, reaction with reagents, and destructive distillation.

In conclusion, it may be said that the work of the various technical committees and sub-committees is now well under way. The project is of great magnitude and of the highest importance. Uniform classification should be a great aid to a better understanding between seller and buyer, and should result in directing each class of coal into the use for which it is most valuable. These uses must be taken into consideration in revising our present classifications. The committee on use classification wishes to enlist interest and cooperation in the project. Help is needed from research, educational, and industrial organizations in collecting data on coal and in solving the many problems that arise in correlating analytical characteristics with constitution and use of the coal. The committee is indeed fortunate in having the valuable cooperation of the Mines Department and National Research Council of Canada. This cooperation will insure uniformity in classifying the coals of North America.

The organization of separate technical committees on scientific and use classification promises to do away with much unprofitable argument in the progress of the work. It provides clean-cut objectives for each group, and permits the scientists to develop their ideas unhampered by commercial considerations. On the other hand, the engineers and commercial men concerned with producing, distributing, and using coal are able as members of the use classification committee to work out their ideas with the advice of the scientific men who compose a minority on the committee. The scientific committee consists chiefly of chemists, geologists, and paleobotanists, but there is also included a minority of practical fuel engineers.

After each of the two technical committees has reached a satisfactory conclusion in the work of classification, and has submitted a report, the entire committee will probably take steps to harmonize use classification and scientific classification in so far as is possible. It is not unlikely that the final result will be a simple system of classification, both scientific and useful.

Respectfully submitted on behalf of the sectional committee,

A. C. FIELDNER,
Chairman.

H. L. GANDY,
Secretary.

REPORT OF COMMITTEE D-7
ON
TIMBER

Committee D-7 on Timber, through its various sub-committees, has been very active during the past year, and reports the following detailed activities of these sub-committees.

Sub-Committee I on Specifications for Timber (C. E. Paul, chairman).—This sub-committee, in cooperation with the Committee on Wooden Bridges and Trestles of the American Railway Engineering Association, has reviewed the Standard Specifications for Structural Wood Joist, Planks, Beams, Stringers and Posts (D 245 – 27)[1] and has agreed upon a number of changes. The changes embody none of substance, with the exception of the omission of Southern Pine from the select grading and the introduction of Dense common for Douglas Fir and Southern Pine. Southern Pine remains in the dense select grade, but it was claimed that any Southern Pine of close grain would also be dense and that it worked a hardship to supply material in a close grained material because it would automatically be dense and hence should be of the dense select grade. Beyond this, all changes were amplifications for the purpose of making the specifications more complete and clearer. The strength of clear wood has been added as a factor of strength and green wood is used as the basis of working stresses. The rules for Structural Grades have been changed to conform to the "Basic Provisions for the Selection and Inspection of Softwood Dimension and Timbers Where Working Stresses are Required," recommended by the Structural Timber Conference held in Chicago, Ill., November 20, 1928, as approved by the Central Committee on Lumber Standards, Chicago, Ill., December 7, 1928. A new section was added on the calculation and determination of working stresses but no changes were made in the working stresses themselves. A number of charts have been added showing the relation between defects and strength. Formulas for the effect of knots have been included together with an explanation of their development. Sections on the effect of shakes and checks and effect of slope of grain have been added as a basis for and to supplement the charts.

Sub-Committee VI on Timber Preservatives.—This sub-committee is recommending a number of changes in the Standard Methods of Sampling and Analysis of Creosote Oil (D 38 – 27)[2] in a detailed report appended hereto. It is also submitting for adoption a number of tables of factors for use in correcting the volume of creosote oil. A slight change is also recommended in the Standard Method of Test for Distillation of Creosote Oil (D 246 - 28).[1] All of these changes have been developed in cooperation with committees of the American Railway Engineering Association, The American Wood Preservers' Association and the U. S. Bureau of Standards.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 581.

[2] *Ibid.*, p. 683.

Sub-Committee X on Nomenclature and Definitions (C. J. Hogue, chairman).—This sub-committee is submitting proposed Tentative Definitions of Terms Relating to Structural Timber, as appended hereto,[2] and recommends that they be accepted for publication as tentative to supersede, when adopted, the present Standard Definitions of Terms Relating to Structural Timber (D 9 - 15).[3]

Sub-Committee XI on Moisture Content of Timber—This sub-committee has continued its investigations and presents a progress report appended hereto as information. As a result of its investigations this sub-committee has developed three methods of test for determination of moisture in timber which it is submitting for publication as information. These procedures are appended hereto[4] for discussion and trial and it is hoped that some additional information may be obtained during the coming year on their value.

The recommendations appearing in this report have been submitted to letter ballot of the committee with the following result:

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARD			
1. Proposed Tentative Definitions of Terms Relating to Structural Timber	24	0	2
II. PROPOSED TENTATIVE REVISION OF STANDARDS			
2. Standard Methods of Sampling and Analysis of Creosote Oil (D 38 - 27)	21	0	5
3. Standard Method of Test for Distillation of Creosote Oil (D 246 - 28)	22	0	4
4. Standard Specifications for Structural Wood Joist, Planks, Beams, Stringers, and Posts (D 245 - 27)	23	0	3

This report has been submitted to letter ballot of the committee, which consists of 26 members; 26 members returned their ballots, of whom 24 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

HERMANN VON SCHRENK,
Chairman.

J. A. NEWLIN,
Secretary.

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[1] 1928 Supplement to Book of A.S. T.M. Standards, p. 163.

[2] See p. 713.—ED.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 697.

[4] See p. 422.

EDITORIAL NOTE

The proposed Tentative Definitions of Terms Relating to Timber were accepted for publication as tentative to supersede, when adopted, the present Standard Definitions of Terms Relating to Structural Timber. The tentative definitions appear on page 713.

The proposed tentative revisions of the Standard Specifications for Structural Wood Joist, Planks, Beams, Stringers and Posts; Methods of Sampling and Analysis of Creosote Oil; and Test for Distillation of Creosote Oil were accepted for publication as tentative and appear on pages 867, 872, 875.

REPORT OF SUB-COMMITTEE VI ON TIMBER PRESERVATIVES

In 1928,[1] this sub-committee reported the work carried out by the U. S. Bureau of Standards to determine accurately the density-temperature and volume-temperature factors for creosote oil. Tables based on this work have been prepared, giving correction factors for each 1° F. observed temperature from 60° F. to 220° F., the standard temperature to which correction is made being 100° F.

As a result of these investigations, the sub-committee is submitting revisions in two standard methods as given in detail below and recommends that these revisions be accepted for publication as tentative.

Standard Methods of Sampling and Analysis of Creosote Oil (D 38 – 27):[2]

Section 4.—Change the last sentence of the first paragraph to read as follows by the addition of the italicized figure and the omission of the words and figure in brackets:

> If more than [2] *3* per cent of water is present, [or if the water is apparently present to an extent in excess of 2 per cent, but an accurate separation is impossible,] the percentage of water present shall be determined by the following method, and the water-free oil so obtained shall be used in the distillation test:

Section 9.—Replace the second and third sentences: namely,

> In case the oil requires to be brought to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by adding 0.0008 to the observed specific gravity for each degree Centigrade above 38° C. at which the test is made. This correction factor does not apply with equal accuracy to all oils, but serious error due to its use will be avoided if the foregoing precaution is observed, with respect to avoiding unnecessarily high temperature.

by a single sentence reading as follows:

> In case it is necessary to bring the oil to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by selecting the appropriate factor from Tables I and II shown in the Appendix.

Add as an Appendix to these methods the accompanying Tables I and II giving factors for use in correcting the volume of creosote oil from observed temperatures to 100° F. Precede the tables with the following introductory paragraph:

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 549 (1928).

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 683.

TABLE I.—FACTORS TO BE USED FOR CORRECTING THE SPECIFIC GRAVITY OF CREOSOTE OIL TO 100° F. WHEN THE OIL IS AT TEMPERATURES RANGING FROM 60 TO 220° F.

GROUP I.—For Distillate Creosote Including Distillate Water-Gas-Tar Creosote, Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Below 1.0900.

GROUP II.—For High-Boiling Distillate Creosote or Anthracene Oils Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Above 1.0900.

Observed Temperature, deg. Fahr.	Correction Factor to be Added to Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Added to Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Added to Observed Specific Gravity	
	Group I	Group II		Group I	Group II		Group I	Group II
220	0.0491	0.0468	180	0.0326	0.0312	140	0.0161	0.0156
219	0.0487	0.0464	179	0.0322	0.0308	139	0.0157	0.0152
218	0.0483	0.0460	178	0.0318	0.0304	138	0.0153	0.0148
217	0.0479	0.0457	177	0.0314	0.0301	137	0.0149	0.0144
216	0.0475	0.0453	176	0.0309	0.0297	136	0.0145	0.0140
215	0.0471	0.0449	175	0.0305	0.0293	135	0.0141	0.0136
214	0.0467	0.0445	174	0.0301	0.0289	134	0.0137	0.0132
213	0.0462	0.0441	173	0.0297	0.0285	133	0.0133	0.0128
212	0.0458	0.0437	172	0.0293	0.0281	132	0.0129	0.0124
211	0.0454	0.0433	171	0.0289	0.0277	131	0.0125	0.0120
210	0.0450	0.0429	170	0.0284	0.0273	130	0.0121	0.0117
209	0.0446	0.0425	169	0.0280	0.0269	129	0.0117	0.0113
208	0.0442	0.0421	168	0.0276	0.0265	128	0.0113	0.0109
207	0.0438	0.0418	167	0.0272	0.0261	127	0.0109	0.0105
206	0.0434	0.0414	166	0.0268	0.0257	126	0.0105	0.0101
205	0.0430	0.0410	165	0.0264	0.0253	125	0.0101	0.0097
204	0.0426	0.0406	164	0.0260	0.0250	124	0.0097	0.0093
203	0.0422	0.0402	163	0.0256	0.0246	123	0.0093	0.0089
202	0.0418	0.0398	162	0.0252	0.0242	122	0.0089	0.0085
201	0.0413	0.0394	161	0.0248	0.0238	121	0.0084	0.0081
200	0.0409	0.0390	160	0.0244	0.0234	120	0.0080	0.0078
199	0.0405	0.0386	159	0.0239	0.0230	119	0.0076	0.0074
198	0.0401	0.0382	158	0.0234	0.0226	118	0.0072	0.0070
197	0.0397	0.0378	157	0.0230	0.0222	117	0.0068	0.0066
196	0.0392	0.0374	156	0.0226	0.0218	116	0.0064	0.0062
195	0.0388	0.0371	155	0.0222	0.0214	115	0.0060	0.0058
194	0.0384	0.0367	154	0.0218	0.0210	114	0.0056	0.0054
193	0.0380	0.0363	153	0.0214	0.0206	113	0.0052	0.0050
192	0.0375	0.0359	152	0.0210	0.0202	112	0.0048	0.0046
191	0.0371	0.0355	151	0.0206	0.0199	111	0.0044	0.0043
190	0.0367	0.0351	150	0.0202	0.0195	110	0.0040	0.0039
189	0.0363	0.0347	149	0.0198	0.0191	109	0.0036	0.0035
188	0.0359	0.0343	148	0.0194	0.0187	108	0.0032	0.0031
187	0.0355	0.0340	147	0.0190	0.0183	107	0.0028	0.0027
186	0.0351	0.0336	146	0.0186	0.0179	106	0.0024	0.0023
185	0.0347	0.0332	145	0.0182	0.0175	105	0.0020	0.0019
184	0.0343	0.0328	144	0.0177	0.0171	104	0.0016	0.0016
183	0.0339	0.0324	143	0.0173	0.0167	103	0.0012	0.0012
182	0.0334	0.0320	142	0.0169	0.0163	102	0.0008	0.0008
181	0.0330	0.0316	141	0.0165	0.0160	101	0.0004	0.0004
						100	0.0000	0.0000

The portion of the table below should not be used unless the sample of oil has been examined and found free from crystals.

Observed Temperature, deg. Fahr.	Correction Factor to be Subtracted from Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Subtracted from Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Subtracted from Observed Specific Gravity	
	Group I	Group II		Group I	Group II		Group I	Group II
99	0.0004	0.0004	84	0.0063	0.0062	69	0.0122	0.0121
98	0.0008	0.0008	83	0.0067	0.0066	68	0.0126	0.0125
97	0.0012	0.0012	82	0.0071	0.0070	67	0.0130	0.0129
96	0.0016	0.0016	81	0.0075	0.0074	66	0.0134	0.0133
95	0.0020	0.0020	80	0.0079	0.0078	65	0.0138	0.0136
94	0.0024	0.0023	79	0.0083	0.0082	64	0.0142	0.0140
93	0.0028	0.0027	78	0.0087	0.0086	63	0.0146	0.0144
92	0.0032	0.0031	77	0.0091	0.0090	62	0.0150	0.0148
91	0.0036	0.0035	76	0.0095	0.0094	61	0.0154	0.0152
90	0.0040	0.0039	75	0.0099	0.0098	60	0.0158	0.0156
89	0.0043	0.0043	74	0.0103	0.0101			
88	0.0047	0.0047	73	0.0107	0.0105			
87	0.0051	0.0051	72	0.0111	0.0109			
86	0.0055	0.0055	71	0.0115	0.0113			
85	0.0059	0.0058	70	0.0118	0.0117			

Table II.—Factors to be Used for Determining the Volume of Creosote Oil at 100° F. When the Oil is at Temperatures Ranging from 60 to 220° F.

Group I.—For Distillate Creosote Including Distillate Water-Gas-Tar Creosote, Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Below 1.0900.

Group II.—For High Boiling Distillate Creosote Oils Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Above 1.0900.

The observed volume is to be multiplied by the factor corresponding to the observed temperature.

Observed Temperature, deg. Fahr.	Volume at 100° F. Occupied by Unit Volume at Indicated Temperature		Observed Temperature, deg. Fahr.	Volume at 100° F. Occupied by Unit Volume at Indicated Temperature		Observed Temperature, deg. Fahr.	Volume at 100° F. Occupied by Unit Volume at Indicated Temperature	
	Group I	Group II		Group I	Group II		Group I	Group II
220	0.9526	0.9570	180	0.9684	0.9711	140	0.9842	0.9855
219	0.9530	0.9573	179	0.9687	0.9714	139	0.9846	0.9858
218	0.9534	0.9577	178	0.9691	0.9718	138	0.9850	0.9862
217	0.9538	0.9580	177	0.9695	0.9721	137	0.9853	0.9866
216	0.9542	0.9584	176	0.9699	0.9725	136	0.9857	0.9869
215	0.9546	0.9587	175	0.9703	0.9729	135	0.9861	0.9873
214	0.9550	0.9591	174	0.9707	0.9732	134	0.9865	0.9876
213	0.9554	0.9594	173	0.9711	0.9736	133	0.9869	0.9880
212	0.9558	0.9598	172	0.9715	0.9739	132	0.9873	0.9884
211	0.9561	0.9601	171	0.9719	0.9743	131	0.9877	0.9887
210	0.9565	0.9605	170	0.9723	0.9746	130	0.9881	0.9891
209	0.9569	0.9608	169	0.9727	0.9750	129	0.9885	0.9894
208	0.9573	0.9612	168	0.9731	0.9754	128	0.9889	0.9898
207	0.9577	0.9615	167	0.9735	0.9757	127	0.9893	0.9902
206	0.9581	0.9619	166	0.9739	0.9761	126	0.9897	0.9905
205	0.9585	0.9622	165	0.9743	0.9764	125	0.9901	0.9909
204	0.9589	0.9626	164	0.9747	0.9768	124	0.9905	0.9913
203	0.9593	0.9629	163	0.9751	0.9772	123	0.9909	0.9916
202	0.9597	0.9633	162	0.9754	0.9775	122	0.9913	0.9920
201	0.9601	0.9636	161	0.9758	0.9779	121	0.9917	0.9923
200	0.9605	0.9640	160	0.9762	0.9782	120	0.9921	0.9927
199	0.9609	0.9644	159	0.9766	0.9786	119	0.9925	0.9931
198	0.9612	0.9647	158	0.9770	0.9790	118	0.9929	0.9934
197	0.9616	0.9650	157	0.9774	0.9793	117	0.9932	0.9938
196	0.9620	0.9654	156	0.9778	0.9797	116	0.9936	0.9942
195	0.9624	0.9658	155	0.9782	0.9800	115	0.9940	0.9945
194	0.9628	0.9661	154	0.9786	0.9804	114	0.9944	0.9949
193	0.9632	0.9665	153	0.9790	0.9808	113	0.9948	0.9952
192	0.9636	0.9668	152	0.9794	0.9811	112	0.9952	0.9956
191	0.9640	0.9672	151	0.9798	0.9815	111	0.9956	0.9960
190	0.9644	0.9675	150	0.9802	0.9819	110	0.9960	0.9963
189	0.9648	0.9679	149	0.9806	0.9822	109	0.9964	0.9967
188	0.9652	0.9682	148	0.9810	0.9826	108	0.9968	0.9971
187	0.9656	0.9686	147	0.9814	0.9830	107	0.9972	0.9974
186	0.9660	0.9689	146	0.9818	0.9833	106	0.9976	0.9978
185	0.9664	0.9693	145	0.9822	0.9837	105	0.9980	0.9982
184	0.9668	0.9696	144	0.9826	0.9840	104	0.9984	0.9985
183	0.9672	0.9700	143	0.9830	0.9844	103	0.9988	0.9989
182	0.9676	0.9704	142	0.9834	0.9848	102	0.9992	0.9992
181	0.9680	0.9707	141	0.9838	0.9851	101	0.9996	0.9996
						100	1.0000	1.0000

The portion of the table below should not be used unless the sample of oil has been examined and found free from crystals.

99	1.0004	1.0004	84	1.0063	1.0057	69	1.0122	1.0111
98	1.0008	1.0007	83	1.0067	1.0061	68	1.0126	1.0115
97	1.0012	1.0011	82	1.0071	1.0065	67	1.0130	1.0118
96	1.0016	1.0014	81	1.0075	1.0068	66	1.0134	1.0122
95	1.0020	1.0018	80	1.0079	1.0072	65	1.0138	1.0126
94	1.0024	1.0022	79	1.0083	1.0075	64	1.0142	1.0129
93	1.0028	1.0025	78	1.0087	1.0079	63	1.0146	1.0133
92	1.0032	1.0029	77	1.0091	1.0083	62	1.0150	1.0136
91	1.0036	1.0032	76	1.0095	1.0086	61	1.0154	1.0140
90	1.0040	1.0036	75	1.0099	1.0090	60	1.0158	1.0144
89	1.0043	1.0040	74	1.0103	1.0093			
88	1.0047	1.0043	73	1.0107	1.0097			
87	1.0051	1.0047	72	1.0111	1.0100			
86	1.0055	1.0050	71	1.0115	1.0104			
85	1.0059	1.0054	70	1.0118	1.0108			

The accompanying Tables I and II were prepared by the U. S. Bureau of Standards to meet the demand of the users and producers of creosote oil for accurate correction factors. The tables have been adopted as standard by the American Wood Preservers' Association and are being considered for adoption by the American Railway Engineering Association; they are the outcome of a Joint Conference Committee representing these associations and the American Society for Testing Materials. Special attention is directed to the importance of the note of warning with regard to measurement of oil at temperatures below 100° F.

Standard Method of Test for Distillation of Creosote Oil (D 246 - 28):[1]

Section 8.—Change the phrase "If the presence of water is suspected or known" to read "If the presence of 3 per cent of water is suspected or known."

Section 10.—Add a new paragraph to read as follows:

(*f*) If the fraction 0 to 210° C. contains water the amount of water shall be determined. This amount shall then be deducted from the weight of oil taken and all of the fractions shall be corrected to a percentage based on dry oil. A convenient method for determining the amount of water is to transfer this fraction, after weighing, to a tube or cylinder graduated in 0.1 cc. and add benzol. This almost always causes a clear separation between the oil and water.

Respectfully submitted on behalf of the sub-committee,

S. R. CHURCH,
Chairman.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 163.

REPORT OF SUB-COMMITTEE XI ON MOISTURE CONTENT OF TIMBER

One of the most important developments during the year in the field of rapid moisture determinations in timber has been the development of the Tag-Heppenstall moisture meter by the C. J. Tagliabue Manufacturing Co. This is the first instrument to appear commercially. It is of a resistance type indicating whether the wood is above or below a desired moisture content by the flashing of a small electric light. The instrument operates between 7 and 24 per cent moisture content. Contact is made on the same side of the wood to be tested by pressing two pairs of electrodes a short distance into the wood.

A few of these instruments are in use but we have no comprehensive data pertaining to their accuracy. One or two other instruments have been reported, but so far the Tag-Heppenstall instrument is the only one that has made its appearance on the market.

Considerable work has been done at the Forest Products Laboratory during the year, including the construction of several electrical instruments.

Experiments directed toward the perfection of the various electrical instruments have shown that each type has certain characteristic defects. In addition there are some sources of error which are more or less common to all types. In the case of resistance machines the principal difficulties and source of error lie within the wood itself. The resistance is so very high at low moisture contents and so very low at high moisture contents that the instruments originally developed could not be used with any degree of accuracy below a moisture content of 6 to 8 per cent or above the fiber saturation point. These instruments lose their accuracy also if the wood has a reasonably steep moisture gradient. More recently it has become evident that the amount of extractives in the wood has a definite influence upon the resistance, and consequently upon the accuracy of the method. It also seems apparent now that the density of the wood is a factor that can no longer be neglected.

One of the principal difficulties encountered with machines using the capacity method is that the density of the wood is a direct factor and unless the density be determined separately or estimated accurately, a definite error is introduced. It was thought at first that it would be possible to use the capacity method for all moisture contents from zero on up, but electrical difficulties in connection with the tuning or adjustment at the higher moisture contents introduces an important source of unreliability. It seems also that the quantity of extractives in the wood has a measurable effect upon the accuracy of the method.

Quite recently it has been shown that the electrical properties of wood, particularly its electrical capacity, seem to vary throughout a wide range with variations in the form and frequency of the current used for measuring them.

During the current year efforts have been concentrated first upon the improvement of electrical resistance methods, and a modified vacuum tube method modelled upon the vacuum tube voltmeter circuit has been developed. This method seems to be a definite step forward in that it is more sensitive and more reliable than previous instruments. It permits reasonably accurate readings at lower moisture contents and also gives promise of being able to get some indications at moisture contents above the fiber saturation point. Second, a good deal of effort has been expended on the capacity machine. This machine was rebuilt and calibrated for use in connection with the current field tests on the drying of Douglas fir.

Development of all the various types of machines has been handicapped by lack of fundamental information on the electrical properties of wood and it has been found necessary to stop development work for the time being to determine these electrical properties more accurately. Especially is it necessary to know the effect of all possible variables upon the electrical capacity and electrical resistance.

It has been found in the case of the wood hygrometer that shipping caused the instruments to become inaccurate in many cases. Work will be carried on in a small way to improve this instrument.

LABORATORY METHODS FOR THE DETERMINATION OF MOISTURE IN TIMBER

Introduction:

In considering the matter of moisture content determinations, three general problems are presented:

1. The moisture content of a given sample.
2. The moisture content of a given board.
3. The moisture content of a large group of boards, that is, of a shipment.

The moisture content of a given sample is the simplest form of the problem and can be handled very easily. However, when we wish to find the moisture content of a board the problem is complicated considerably. It must be decided where the sample is to be taken from the board. It is obvious that we cannot test the whole board but it is desired that the sample taken shall give a fair representation of the remainder of the piece.

In order to apply moisture content determinations to commercial work we are no longer dealing with a single sample but with a large number and it is evident that it is impractical to test each individual piece by means of laboratory methods. The problem resolves itself into the matter of selecting a fair number of samples from a shipment to be reasonably sure that the shipment is represented.

It is further desired not to waste any more material than necessary inasmuch as some loss of material is involved when a moisture section is cut from a board.

Statistical methods probably provide the best opportunity for an adequate solution of this phase of the problem.

TABLE I.—TIME REQUIRED FOR THE DETERMINATION OF MOISTURE IN FOUR THICKNESSES OF BIRCH BY OVEN DRYING AT 110° C.

Data by Bateman and Beglinger.

Time, hours	Moisture Content, per cent			
	$\frac{1}{8}$ in. Thick	$\frac{1}{4}$ in. Thick	$\frac{1}{2}$ in. Thick	1 in. Thick
3	....	8.57	9.50	8.63
6	8.0[a]	9.72	9.91	9.09
22	8.88	9.72	9.91	9.09
29	8.88	9.72	9.91	9.09
44	8.88	9.72	9.91	9.09

[a] This value does not appear consistent but was actually obtained in collecting the data.

Moisture Content of a Single Sample:

Three methods of moisture determination in wood are available for laboratory use which are capable of giving accurate results. They are known as oven-dry, xylol, and oven-distillation methods. The oven-dry method is the most commonly used and for many woods is quite satisfactory when carried out under proper conditions. In some cases wood contains volatile oils or has been impregnated with volatile treating oils which may be distilled off when heated and consequently cause an error in the results. When volatile oils are present the xylol or oven-distillation methods are more satisfactory.

Oven-Dry Method.—The oven-dry method is quite well known and extensively used. The method consists in weighing the sample, placing it in a temperature-controlled oven between 105 and 110° C. until the moisture has been driven off, when the specimen is reweighed, the loss calculated and the percentage of moisture determined based on the oven-dry weight.

For accurate work the samples should remain in the oven until they reach constant weight. This usually requires a period of several hours. It is customary in good work to allow the samples to remain in the oven over night. Table I taken from the work of Bateman and Beglinger[1] shows that if these blocks had been left in the oven only an hour or so an appreciable error would have resulted. If a limited time is used weighings should be repeated to make sure that constant weight is reached. The practice in some plants of drying specimens one or two hours is not considered good.

Ovens should be equipped with thermostats and thermometers so that the temperature may be correctly maintained.

It is important also not to over-crowd the oven as this greatly retards drying and may cause serious errors.

Volatile Solvents Method (Xylol).—The volatile solvents method, as it is called when it is used for the determination of moisture in petroleum or bituminous products, is sometimes used for determinations of moisture in wood. In this case xylene is used instead of gasoline, kerosine or naptha as specified in the A.S.T.M. Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 - 28)[2].

The sample should be weighed and may be split up parallel to the grain so as to be placed in the flask and sufficient xylene added to cover the wood.

A condenser is then attached to the mouth of the flask and heat applied. The distilled moisture is collected in a calibrated glass receiving tube and measured. Distillation is continued until no more water is given off by the sample. Heat supplied by an electric plate is preferable to an open flame because of the inflammable nature of the xylene. The test is carried out at the boiling point of xylene (140° C.) and it has been shown that the moisture determined by this method checks with the oven-dry method operating at 110° C.

One to seven hours are required to make this test, depending on the size of the parts making up the sample.

The moisture content of the wood may be calculated by subtracting the weight of water, as measured in the receiving tube, from the original weight, dividing by the moisture-free weight of the wood and multiplying by 100. When volatile oils are present they are calculated as a part of the wood.

Where a large number of samples are to be tested a group of distillations may be carried on at the same time.

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[1] Bateman and Beglinger, "Experiments on the Determination of Moisture in Wood by Laboratory Methods," *Proceedings*, Am. Wood Preservers' Assn., January, 1929.

[2] 1928 Supplement to Book of A.S.T.M. Standards, p. 148.

Oven-Distillation Method.—The oven-distillation method, devised at the Forest Products Laboratory, is very much like the xylol method except that no volatile solvents are used. The moisture sample as taken is weighed and placed in a cylinder which is enclosed in an insulated oven, shown in Fig. 1, operated at a temperature of 105 to 110° C. This cylinder is connected by copper tubing to a vertical condenser at the rear of the oven and by another copper tube leading from the condenser to the cylinder so that circulation of air is produced in the apparatus when in operation. The water from the sample is collected in receiving tubes below the condenser as is done

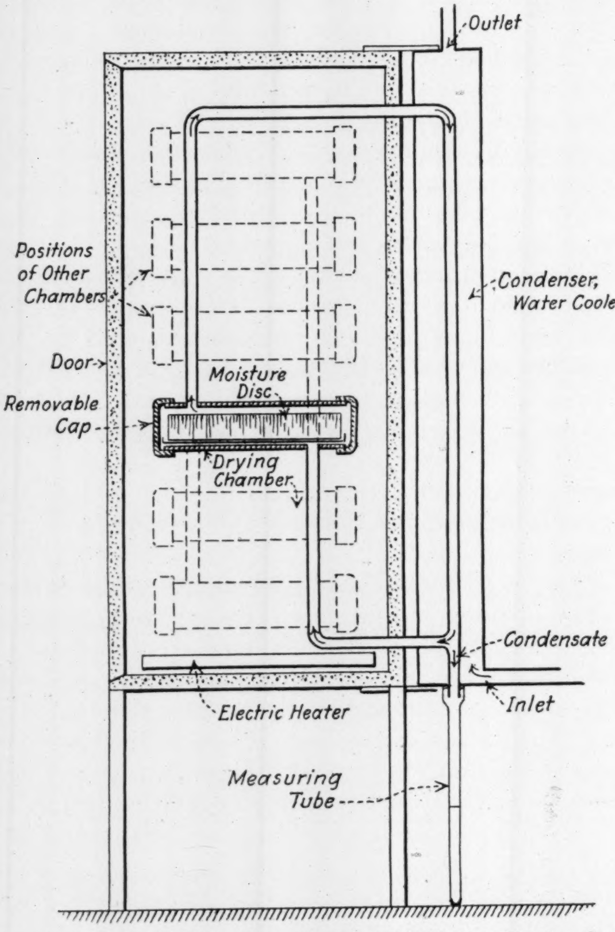
Outlet
Positions of Other Chambers
Condenser, Water Cooled
Door
Moisture Disc
Removable Cap
Drying Chamber
Condensate
Inlet
Electric Heater
Measuring Tube

FIG. 1.—Lateral Section Through Oven-Distillation Drying Oven.

in the case of the xylol method. In this test volatile oils are collected above the water and in this way may be determined. This is important where treating oils are present and is a marked advantage over the volatile solvents method because it permits a better basis for the calculation of the moisture content.

This method requires practically no attention and of course does not make use of inflammable solvents. It has not been used to any known extent outside of the Forest Products Laboratory.

The calculations are made by subtracting the weight of water from the original weight of the wood, dividing the weight of water by this result and multiplying by 100, which gives the results as a percentage. A partial correction may be introduced where treating oils are present if it is desired.

TABLE II.—LONGITUDINAL DISTRIBUTION OF MOISTURE IN ASH AT SUCCESSIVE STAGES OF DRYING (4 BY 4 BY 48 IN.).[1]

Board	Elapsed Time, hours	Moisture Content at Distance Indicated from Left End, per cent										
		½ in.	1½ in.	7⅛ in.	12¾ in.	18¾ in.	24 in.	29⅝ in.	35¼ in.	40⅞ in.	46½ in.	47½ in.
No. 1........	0	29.6	48.1	....	54.4	....	55	....	47.3	....	72.8	29.8
No. 2........	24	34.8	57.0	....	63.4	....	63.7	....	56.7	....	48.6	33.4
No. 3........	96	27.6	46.7	....	56.7	....	56.3	....	45.8	....	40.4	35.1
No. 4........	168	17.0	31.0	....	33.5	....	33.3	....	33.2	....	30.6	18.3
No. 5........	336	12.4	22.7	31.4	30.7	31.0	30.6	31.1	29.9	28.6	26.4	13.7
No. 6........	408	12.5	28.1	26.4	28.5	29.8	30.8	27.2	27.2	28.8	19.4	11.9
No. 7........	456	11.3	18.5	30.5	28.7	30.6	31.9	30.2	30.0	31.1	23.2	12.2
No. 8........	504	10.3	15.9	26.5	26.1	25.0	24.8	24.6	22.8	23.8	16.3	9.5
No. 9........	552	8.6	16.0	24.6	25.1	25.2	25.4	25.0	24.3	24.8	12.5	8.7
No. 10......	600	7.9	12.8	25.6	23.9	24.8	25.2	23.4	20.0	16.6	9.4	7.0
No. 11......	672	7.6	9.4	....	19.2	20.7	21.5	21.1	19.6	....	10.6	7.0

[1] Investigation on the artificial seasoning of ash in a Sturtevant kiln.

The test requires in the neighborhood of 48 hours and may be justified for certain classes of work where time is not important. It requires no attention and in addition gives additional information on volatile oils present.

Moisture Content of a Board:

Sampling.—The problem of determining the moisture content of a board is rendered more difficult for the reason that the moisture content is very seldom evenly distributed throughout its length and may show considerable variations. The committee at present sees no clear way out of this difficulty but presents in Tables II, III and IV such data as it has been able to collect.

Table II gives the most complete information on the moisture content of ash bolts during the process of drying. The work was done by Percy Groom and the ash bolts were cut up from time to time as the kiln drying proceeded. This work shows very clearly the great variations that may exist in wood as it dries. The center 24 in. of the 4-ft. ash bolts appeared to be fairly uniform in moisture content. The greatest effect of end drying is shown in the first few inches of each end.

Table III records data of an unknown species and dimension except as to length. In this case, end drying seems to have affected the moisture content for a distance of about 6 in.

Table IV gives some information on the longitudinal distribution of moisture in a 2 by 5½ by 48-in. laurel oak plank. End drying affected only about 2 in. of the piece.

TABLE III.—DISTRIBUTION OF MOISTURE IN A 2-IN. BOARD WHEN DRYING FROM A GREEN CONDITION.

16-ft. board cut into eight 2-ft. pieces each containing the following moisture contents, respectively: 30.42; 33.15, 33.70; 32.10; 32.40; 31.90, and 31.70. Species or dimensions not given. Data from chart by W. K. Loughborough; Forest Products Laboratory.

Distance from Left End, in.	Moisture Content, per cent	Distance from Left End, in.	Moisture Content, per cent
0 to ½	10.3	3½ to 4	20.3
½ to 1	13.1	4 to 4½	20.9
1 to 1½	15.1	4½ to 5	21.4
1½ to 2	16.6	5 to 5½	21.8
2 to 2½	17.8	5½ to 6	22.2
2½ to 3	18.8	11¾ to 12¼	22.8
3 to 3½	19.5		

TABLE IV.—LONGITUDINAL MOISTURE DISTRIBUTION OF LAUREL OAK; 2 BY 5½ BY 48 IN.

Seasoning of Southern Swamp Oak for Vehicle and Artillery Parts—W. K. Loughborough, Forest Products Laboratory report.

Distance from End, in.	Moisture Content, per cent	Distance from End, in.	Moisture Content, per cent
0	17	2½	43
½	37	3	43
1	41	4	43
1½	42	7	43
2	43		

The information given is very meager and further work in this field would be very desirable. It appears that no optimum position in a given board can be named and the only restriction that could be justified at the present time would be to take the sample far enough from the end to prevent errors caused by end drying or absorption. The sample should be taken not less than 1 ft. from the end of the board and may be taken at any intermediate point near a defect or cutting point.

Sample.—That the moisture section should be taken across the board and should be at least 1 in. and preferably 2 in. with the grain has been shown by Bateman and Beglinger in a report already cited. This provision is made because it has been found that the heat generated in the sawing operation causes a loss of moisture by the sample. This is important where very accurate measurements are made but for ordinary lumber it is probably not very important because of irregularities which may exist in a given board. Sharp saws cause less drying than dull saws. It has been similarly found that samples taken in the form of borings are also affected by the drilling process and a sharp bit should be used.

TABLE V.—MOISTURE CONDITION OF LUMBER AT TIME OF SHIPMENT.

Species	Seasoning	Number of Tests	Moisture Content, per cent				
			Mean	Standard Deviation	Standard Deviation of Mean	Maximum	Minimum
Douglas fir[1]	Kiln-dried	45	13.2	7.2	1.07	42.9	6.9
White fir[1]	Kiln-dried	60	6.3	0.92	0.12	10.6	5.1
	Air-dried	42	12.0	8.3	1.28	39.7	6.2
	Kiln-dried	32	14.9	4.1	0.73	34.5	11.6
Western yellow pine[1]	....	99	9.0	3.0	0.30	16.0	7.4
	....	33	7.0	1.3	0.23	11.1	4.6
	....	98	6.9	1.2	0.12	9.4	3.8
	....	99	9.6	3.0	0.30	30.6	6.4
	....	95	12.8	1.6	0.17	17.5	9.6
	Kiln-dried	53	3.5	2.9	0.4	11.9	0
	Air-dried	37	7.5	3.5	0.58	22.5	0.3
Sugar pine	....	60	7.0	1.4	0.18	10.5	2.5
	....	8	10.1	0.61	0.22	11.3	9.3
Western white pine	....	103	15.4	1.7	0.16	21.8	11.7
	....	103	15.9	2.6	0.26	30.2	8.7
Western larch[1]	....	102	20.2	5.5	0.55	40.7	10.8
	....	33	23.9	9.4	1.64	47.0	11.3
Southern yellow pine[2]	Kiln-dried	60000	....	2.0	....	....	....

[1] From Table 27, "Study of Specific Gravity, Moisture Content at Time of Shipment and Shrinkage of Western Softwoods," W. K. Loughborough, Project 252-5, Aug. 1, 1928, Forest Products Laboratory.

[2] From "The Shipping Moisture Content Survey of Southern Yellow Pine," in course of preparation—W. K. Loughborough, Forest Products Laboratory.

When samples are prepared for the xylol method and a small neck flask is used the specimens may be split in small pieces parallel to the grain to permit entrance to the flask. This operation should be accomplished as rapidly as possible to avoid loss or gain in moisture.

Moisture Content of a Shipment:

The most important phase of moisture determination in wood is the selection of a number of samples from a shipment both from the point of view of fairness and economy. Any method of sampling involves some chance that the shipment will not be classified correctly. The larger the sample the less chance there is that the material will be different from the sample. For practical purposes, however, the sample should be as small as possible and yet give a fair representation of the shipment, particularly in view of the fact that in cutting moisture sections some loss of material is involved.

TABLE VI.—NUMBER OF SAMPLES REQUIRED TO GIVE AN ACCURACY OF ±1 PER CENT FOR SEVERAL STANDARD DEVIATIONS.

Standard Deviation (σ), per cent	Percentage of Area Within the Range Set by the Average			
	50	68	95	99.5
	($\pm 0.6745\sigma$)	($\pm 1\sigma$)	($\pm 2\sigma$)	($\pm 3\sigma$)
0.5	1	1	1	2
1.0	1	1	4	9
2.0	2	4	16	37
3.0	4	9	36	33
4.0	7	16	64	147
5.0	11	25	100	230
6.0	16	36	144	330
7.0	22	49	196	450
8.0	29	64	256	588
9.0	37	81	324	727
10.0	46	100	400	918
Formula	$N = \left(\frac{\frac{\sigma}{\epsilon}}{0.6745}\right)^2$	$N = \left(\frac{\sigma}{\epsilon}\right)^2$	$N = \left(\frac{\frac{\sigma}{\epsilon}}{2}\right)^2$	$N = \left(\frac{\frac{\sigma}{\epsilon}}{3}\right)^2$

NOTE.—N = number of samples.
σ = standard deviation.
ϵ = allowable error (±1 per cent).

TABLE VII.—NUMBER OF SAMPLES REQUIRED TO GIVE AN ACCURACY OF ±2 PER CENT FOR SEVERAL STANDARD DEVIATIONS.

Standard Deviation, per cent	Percentage of Area Within the Range Set by the Average			
	50	68	95	99.5
	($\pm 0.6745\sigma$)	($\pm 1\sigma$)	($\pm 2\sigma$)	($\pm 3\sigma$)
0.5	1	1	1	1
1.0	1	1	1	2
2.0	1	1	4	9
3.0	1	2	9	20
4.0	2	4	16	36
5.0	3	6	25	56
6.0	4	9	36	81
7.0	6	12	49	105
8.0	7	16	64	144
9.0	9	20	81	183
10.0	11	25	100	223
Formula	$N = \left(\frac{\frac{\sigma}{\epsilon}}{0.6745}\right)^2$	$N = \left(\frac{\sigma}{\epsilon}\right)^2$	$N = \left(\frac{\frac{\sigma}{\epsilon}}{2}\right)^2$	$N = \left(\frac{\frac{\sigma}{\epsilon}}{3}\right)^2$

NOTE.—N = number of samples.
σ = standard deviation.
ϵ = allowable error.

Our only guide to the solution without merely arbitrarily naming a certain number of samples lies in the use of statistical methods. This has been used for many years in the solution of similar problems.

It is not intended in this report to justify the formulas used but to accept them upon the basis of well-known authorities[1] in this field.

Fortunately, some information is available on the standard deviation of several kinds of lumber from which it is possible to obtain an idea of the number of samples to select from a given shipment. The data probably do not cover the field very completely and include no hardwoods, but they will serve to give an idea of the number of samples for a fair representation of the moisture content of a shipment. These data are further supported by a much larger number of tests made on western species which have not been completely analyzed.

Table V gives the results of tests made by the Forest Products Laboratory for seven different species and from a number of different mills. The maximum standard deviation taken from this group of measurements was 9.4 per cent. For either well-seasoned air-dried or kiln-dried lumber the standard deviation would be much lower than 9.4 per cent as is indicated in Table V. For samples with as high a standard deviation as 9.4 per cent, the average of 20 moisture determinations will indicate for practical purposes the true average of the shipment within ± 2.1 per cent. The exact relationship between number of determinations and true average is shown in Tables VI and VII.

The procedures appended hereto are suggestions for discussion and trial and it is hoped that some additional information may be obtained during the coming year on their value.

Respectfully submitted on behalf of the sub-committee.

M. E. DUNLAP,
Chairman.

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[1] Chapter 9 of "A Textbook on the Method of Least Squares," by Mansfield Merriman (eighth edition).

APPENDIX

PROPOSED METHODS OF TEST FOR DETERMINATION OF MOISTURE IN TIMBER

METHOD A. TIMBER CONTAINING NO VOLATILE CONSTITUENTS

1. *Scope.*—This method of test is known as the oven-dry test and is suitable for laboratory use to determine the quantity of moisture present in timber containing no volatile constituents.

2. The apparatus shall consist of the following:

(*a*) *Oven.*—A temperature-regulated oven capable of being maintained at a temperature between 105 and 110° C. with ample capacity to provide adequate circulation about the samples.

(*b*) *Thermometer.*—A thermometer accurate to 1° C.

(*c*) *Balance.*—A balance, the accuracy of which shall be 0.5 per cent.

3. *Test Specimen.*—The test specimen shall be cut so that it will measure at least 1 in. and preferably 2 in. along the grain in order to eliminate the drying effect of the sawing operation. The specimen shall be taken not less than 12 in. from the end of the timber but may be taken at any intermediate point near a defect or cutting point. When moisture determinations are made on ties or large timbers and it is impractical to cut a test specimen, borings produced by a sharp auger bit may be used.

4. *Number of Specimens.*—When the moisture content of a shipment of timber is to be determined, 20 specimens shall be selected at random.

5. *Procedure.*—The specimen shall be weighed immediately after selection and placed in the oven maintained at a temperature of 105 to 110° C. The specimen shall be allowed to remain in the oven until it has reached constant weight. In many cases, the greater portion of the moisture will be driven off in 24 hours but some species may require longer periods of heating. Atmospheric conditions may at times prevent rapid drying.

6. *Calculation.*—Calculate the percentage of moisture in the specimen by dividing the loss in weight by the oven-dry weight and multiply by 100.

7. *Accuracy.*—This test should give an accuracy of about 0.5 per cent.

METHOD B. TIMBER CONTAINING VOLATILE CONSTITUENTS

a. Volatile Solvents or Xylol Method:

8. *Scope.*—This method of test is known as the volatile solvents or xylol method and is suitable for laboratory use to determine accurately the quantity of moisture present in timber when there are volatile constituents present such as natural oils, timber-preserving oils, and other similar constituents, and may, if desired, be used as an alternate method for timbers containing no volatile matter instead of Method A described in Sections 1 to 7, inclusive, or method *b* described in Sections 14 to 19, inclusive.

9. The apparatus shall consist of the following:

(*a*) *Distillation Apparatus.*—The distillation apparatus shall conform to the requirements specified in Sections 2 to 6 of the Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials (A.S.T.M. Designation: D 95) of the American Society for Testing Materials.[1]

(*b*) *Balance.*—A balance, the accuracy of which shall be 0.5 per cent or better.

10. *Test Specimen.*—The test specimen shall be selected in accordance with Sections 3 and 4.

11. *Procedure.*—The specimen shall be weighed immediately after selection and placed in the distillation flask. If the specimen is too large to fit into the flask it may be split up parallel to the grain in pieces just large enough to pass through the neck of the flask. A quantity of xylol sufficient to cover the sample shall be added. The connections between the still or flask, trap and condenser shall be made tight by means of tight-fitting corks. When the metal still is used a heavy paper gasket moistened with the solvent shall be inserted between the lid and flange before attaching the clamp. A loose cotton plug shall be inserted in the top of the condenser tube to prevent condensation of atmospheric moisture in the condenser tube.

Heat shall then be applied and so regulated that the condensed distillate falls from the end of the condenser at the rate of two to five drops per second. The ring burner used with the metal still should be placed about 3 in. above the bottom of the still at the beginning of the distillation and gradually lowered as the distillation proceeds.

The distillation shall be continued at the specified rate until no water is visible on any part of the apparatus except at the bottom of the trap. A persistent ring of condensed water in the condenser tube shall be removed by increasing the rate of distillation for a few minutes.

The time required varies from one to seven hours, depending on the size of pieces making up the specimen.

12. *Calculation.*—The volume of condensed water measured in cubic centimeters (taken as grams of water) in the trap at the average of the meniscus is subtracted from the original weight giving the oven-dry weight of the sample. The loss in weight divided by the oven-dry weight and multiplied by 100 gives the percentage of water in the sample on a moisture-free basis.

When volatile oils are present they are calculated as a part of the wood substance in this calculation.

13. *Accuracy.*—The accuracy to be expected with this method should be greater than 0.5 per cent for individual specimens.

b. Dry Distillation Method:

14. *Scope.*—This test is known as the dry distillation method and is suitable for laboratory use to determine the quantity of moisture present in timber when there are volatile constituents present such as natural oils, timber-preserving oils and other similar constituents, and may be used as an alternate method for method *a* for volatile solvents or xylol described in Sections 8 to 13, inclusive, and when no volatile constituents are present for Method A described in Sections 1 to 8 inclusive. This test also permits the measure of the major part of volatile oils.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 148.

15. The apparatus shall consist of the following:

(*a*) *Oven.*—A thermostatically-controlled electric oven[1] in which any convenient number of secondary chambers may be housed. The oven shall have at the rear a condenser and below it the receiving or measuring tubes.

The secondary chambers shall be copper or brass cylinders 2½ in. in inside diameter and of a convenient length with a removable door facing the oven door. This door shall be tight-fitting to prevent the leakage of moisture. The drying compartment shall be connected at the top with a ½-in. copper tube leading to the top of the condenser and after passing through the condenser the pipe shall branch, one branch leading to the measuring tube and the other returning to the drying compartment so as to provide circulation. The compartment shall be provided with a pan to retain any resins that may exude from the specimen. The oven shall be maintained at a temperature between 105 and 110° C. Tap water may be used in the condenser. The operation of the apparatus depends on the difference in gravity of the hot and cold columns of air. The condenser tubes shall be long enough to provide good circulation. Condenser tubes 30 in. in length have been found satisfactory.

(*b*) *Balance.*—A balance, the accuracy of which shall be 0.5 per cent or better.

16. *Test Specimen.*—The test specimen shall be selected in accordance with Sections 3 and 4.

17. *Procedure.*—The specimen shall be weighed immediately after selection and placed in the pan inside of the drying compartment. The door shall be made air-tight and the joint between the measuring and condenser tubes made tight. The heat shall be turned on and the flow of water in the condenser started. The distillation shall be continued until no further condensate collects in the measuring tube. The average of the meniscus shall be read on the measuring tube and recorded. About 48 hours are usually required but this time is justified where a large number of samples are to be tested. No attention is required and the use of no inflammable liquid is involved.

18. *Calculations.*—Divide the weight of the condensate by the difference between the original weight of the specimen and the weight of the condensate; multiply by 100 and the result will be expressed as a percentage of the oven-dry weight.

19. *Accuracy.*—If the specimen contains about 10 g. of water the accuracy of this test is about 1 per cent.

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[1] See Fig. 1, p. 416.—ED.

REPORT OF COMMITTEE D-8

ON

BITUMINOUS WATERPROOFING AND ROOFING MATERIALS

As the result of its work during the past year Committee D-8 offers one new specification and one new method of test, and recommends the revision of one existing tentative method and one standard specification.

Further cooperative work on the Methods of Analysis of Roofing Felt for Fiber Composition (D 272 – 27 T) has been carried on by Sub-Committee VI on Methods of Fiber Analysis. The results of the collaborative work on five samples of felts is published in an appendix to this report and it is believed they will be of considerable value to those interested in these methods and also furnish a basis for the revisions in these methods which are being recommended by the committee.

The committee is not recommending for advancement to standard the Tentative Specifications for Acid-Resisting Asphalt Mastic (D 223 – 25 T) which have been tentative for over three years, and feels that in view of new developments in the art, the specifications should be held as tentative for at least one more year.

Committee D-8 has reviewed the proposed report of the Conference Committee, composed of representatives of Committees D-2 on Petroleum Products and Lubricants, D-4 on Road and Paving Materials and D-8, dealing with definitions of the terms bitumen, asphalt, tar, pitch and flux, and has formally approved that report.

PROPOSED NEW TENTATIVE STANDARDS

The committee recommends for publication as tentative, as appended hereto,[1] the following new specifications and method of test:

Proposed Tentative Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings;

Proposed Tentative Method of Test for Coarse Particles in Bituminous Materials by Means of Elutriation.

PROPOSED REVISION OF EXISTING STANDARD SPECIFICATIONS

Standard Specifications for Asphalt Roll-Roofing and Asphalt Shingles Surfaced with Mineral Granules (*D 225 – 27*).[2]—In order to meet criticisms which have been received and to make these specifications conform more closely to customary practice, the following revision is recommended:

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[1] See pp. 719 and 722, respectively.—ED.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 753.

Section 7 (j).—Add a note to this section to read as follows:

NOTE.—Should the weight exceed the above amount, the material shall nevertheless be acceptable provided the finished weight per 108 sq. ft. is increased by a like amount over the requirements specified in Paragraph (*d*).

It is recommended that this revision be incorporated in the present standard method without publication as tentative. The committee accordingly asks for the necessary nine-tenths vote for adoption of this revision as standard immediately.

PROPOSED REVISION OF EXISTING TENTATIVE METHODS OF ANALYSIS

Tentative Methods of Analysis of Roofing Felt for Fiber Composition (D 272 - 27 T).[1]—In order to meet criticisms which have been received and to increase the accuracy of these methods the following revisions are recommended:

Section 5.—Change to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

5. Ten grams of the sample shall be treated in a 400-cc. beaker with 200 cc. of [NaOH solution (0.5-per-cent)] *water* and heated to boiling. Stir the liquid thoroughly, preferably with a mechanical stirrer, until the sample is well pulped and the fibers well separated. The mass shall then be placed on a No. 100 (149 micron) sieve and washed thoroughly with water. The moist mass of paper retained on the sieve shall then be rolled into a ball and worked between the fingers to loosen the fibers thoroughly. Approximately one-fourth of this sample shall then be placed in a stoppered bottle and shaken thoroughly with 250 cc. of water until the fiber mass is thoroughly disintegrated and separated. [Transfer about 25 cc. of this suspension to another bottle and dilute with water to 250 cc. so as to obtain a suspension of about 0.1 per cent pulp. This suspension shall be thoroughly shaken before withdrawing a sample for the micro scope test described in Section 6.] *Transfer three 25-cc. portions of this suspension to separate bottles and dilute each with water to 250 cc., so as to obtain suspensions of about 0.1 per cent pulp. These suspensions shall be thoroughly shaken before withdrawing samples for the microscope tests described in Section 6.*

Section 7.—In the first paragraph, omit the last three sentences reading as follows:

Select two or more up-and-down paths and repeat the process. In this manner not less than 200 fibers shall be counted on each slide, depending upon the thickness of fibers on the slide. An examination of three such slides, involving the counting of not less than 600 fibers, shall constitute a test.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 968 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 581.

and substitute the following:

In this manner not less than 300 fibers shall be counted on each slide using one or more up-and-down paths if necessary to obtain the required number. Each slide shall be calculated separately and the results for the different constituents compared with the average result. These shall agree with the average within the following permissible variations:

Cotton	$\pm \sqrt{\text{Average}}$
Chemical wood	$\pm (\sqrt{\text{Average}} + 1)$
Mechanical wood	$\pm (\sqrt{\text{Average}} + 2)$
Jute and Manila	$\pm (\sqrt{\text{Average}} + 3)$

If such agreement is not obtained, additional slides shall be made from new 0.1-per-cent suspensions and examined until three results are obtained which fall within the specified limits. The average of three such slides shall be reported as the result of the analysis.

NOTE.—To illustrate the application of the above tolerances, suppose the average of three slides for a given constituent is found to be 33 per cent. The square root of 33 is 5.7. Therefore, all individual results shall lie between 27.3 and 38.7 per cent if the constituent is cotton, and between 26.3 and 39.7 per cent if chemical wood, etc.

It is recommended that these methods, as revised, be continued as tentative.

The results of the letter ballot of the committee upon the recommendations made in this report are given in the following table:

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARDS			
Tentative Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings	33[a]	5[a]	12[a]
Tentative Method of Test for Coarse Particles in Bituminous Materials by Elutriation	35	2	13
II. PROPOSED REVISION OF EXISTING STANDARD			
Standard Specifications for Asphalt Roll-Roofing and Asphalt Shingles Surfaced with Mineral Granules (D 225 - 27)	34	1	15
III. PROPOSED REVISION OF EXISTING TENTATIVE STANDARD			
Tentative Methods of Analysis of Roofing Felt for Fiber Composition (D 272 - 27 T)	32	3	15

[a] The classified vote on the Tentative Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings was as follows: Affirmative, 17 Producers, 7 Consumers, 9 General Interests; Negative, 5 Producers; Not Voting, 6 Producers, 6 Consumers.

This report has been submitted to letter ballot of the committee, which consists of 50 members; 41 members returned their ballots, of whom 38 have voted affirmatively and 2 negatively.

Respectfully submitted on behalf of the committee,

S. T. WAGNER,
Chairman.

PRÉVOST HUBBARD,
Secretary.

EDITORIAL NOTE

The proposed Tentative Specifications for Asphalt for Use in Constructing Built-Up Roof Coverings and Tentative Method of Test for Coarse Particles in Bituminous Materials by Means of Elutriation were accepted for publication as tentative and appear on pages 719 and 722, respectively.

The proposed revision of the Standard Specifications for Asphalt Roll-Roofing and Asphalt Shingles Surfaced with Mineral Granules was approved at the annual meeting by a nine-tenths vote and was subsequently adopted by letter ballot of the Society on September 3, 1929. The standard specifications in their revised form appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 157.

The proposed revision of the Tentative Methods of Analysis of Roofing Felt for Fiber Composition was accepted. The tentative methods in their revised form appear on page 724.

REPORT OF SUB-COMMITTEE VI ON METHODS OF FIBER ANALYSIS

In 1927, the sub-committee submitted the Tentative Methods of Analysis of Roofing Felt for Fiber Composition (D 272 – 27 T).[1] Appended to the report of Committee D-8 for that year[2] were the results of some cooperative tests on four felt samples furnished by the U. S. Bureau of Standards. The sub-committee felt that further cooperative testing was desirable and accordingly arranged to have five samples of felt made on hand machines and of supposedly known composition.

Three samples known as E, F and G were prepared by the Barber Asphalt Co., and described by that company as follows:

> We give below the anticipated composition of these three samples:
>
> | | Sample E | Sample F | Sample G |
> |---|---|---|---|
> | Wool, per cent | 5 | 5 | .. |
> | Cotton, per cent | 30 | 30 | 5 |
> | Chemical Wood, per cent | 30 | 30 | 40 |
> | Mechanical Wood (Sawdust), per cent | 30 | .. | 15 |
> | Mechanical Wood (Wood Flour), per cent | .. | 30 | .. |
> | Jute and Manila, per cent | 5 | 5 | 40 |
>
> Referring to the question of shrinkage our felt mill carefully selected and dusted the rag stocks, beat each stock separately, dried the beaten pulp and took known weights of the bone-dry pulps to the percentages stated in the above tabulation. The regular stocks are selected to give many different colored fibers the same as would be found in regular plant production, and further describe the character of rags used as follows:
>
> *Wool.*—As none of the formulas calls for more than 10 per cent of wool, it should be pure wool. Our experience with shoddy is that it contains from 5 to 8 per cent of other fibers. We have selected pieces of wool felts and colored wool suitings.
>
> *Cotton.*—We selected colored cottons from garments containing probably a small percentage of pure linen.
>
> *Chemical Wood.*—We used new sulfite pulp in sample E and new sulfate pulp in sample G.
>
> *Mechanical Wood.*—Since there is a question of distribution of sawdust and wood flour we have included the same formula in samples E and F to detect the difference between wood flour and sawdust.
>
> *Jute and Manila.*—No comments.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 968 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 581.

[2] See *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 521 (1927).

Two other samples, H and I, were prepared by Bird and Son and described as follows:

> The following is an outline of the preparation of these samples as completed in our laboratory:
>
> *Wool.*—From 100 per cent woolen felt.
> *Cotton.*—Medium grade of raw cotton from inside of quilts.
> *Jute.*—From good grade of bagging.
> *Manila.*—New fiber, unworked.
> *Sulfate.*—Pulp sheets, as received.
> *Ground Wood.*—As received from pulp mill.
>
> The wool, cotton, jute, and manila were washed twice in hot water and then well rinsed. Shrink tests were run on the washed materials. The sulfate and ground wood were used as received.

Shrink Tests:

Cotton	2.5 per cent
Wool	11.5 per cent
Sulfate	2.6 per cent
Ground Wood	2.8 per cent
Manila	11.1 per cent
Jute	7.5 per cent

The following formulas were used:

GROSS	SAMPLE H	SAMPLE I
Wool, per cent	10	..
Cotton, per cent	60	10
Sulfate, per cent	10	20
Ground Wood, per cent	20	40
Manila, per cent	..	20
Jute, per cent	..	10
Theoretical shrink, per cent	3.35	4.84
Actual shrink, per cent	2.11	4.12

ACTUAL NET FORMULA FINISHED SAMPLES		
Wool, per cent	9.1	....
Cotton, per cent	60.7	10.3
Sulfate, per cent	10.1	20.5
Ground Wood, per cent	20.1	40.8
Manila, per cent	....	18.7
Jute, per cent	....	9.7

These samples were distributed to fourteen laboratories who agreed to cooperate and test the samples following the Methods D 272 – 27 T, the results shown in Table I being reported by eleven of the laboratories, three failing to report.

The following general comments may be made on these tests:

Wool.—The cooperating laboratories as a general thing, failed to find wool when it was present.

Cotton.—The average results on cotton are low in sample E and high in samples G and H, while in the case of samples F and I they are nearly correct.

TABLE I.—RESULTS OF COOPERATIVE TESTS ON ANALYSIS OF FELTS FOR FIBER COMPOSITION.

	Wool, per cent	Cotton, per cent	Chemical Wood, per cent	Mechanical Wood, per cent	Jute and Manila, per cent
SAMPLE E					
Supposed Composition	5	30	30	30	5
Abraham	0	23	40	33	4
Berger	0	23.4	38	32.7	5.9
Codwise	0	24	47	25	4
Codwise (estimation method)	trace	28	40	25	7
Hochstadter	0.6	11	48.3	27.6	11
Miller	0.9	29	41.4	28	0.7
Montgomery	0	30	35	30	5
Reeve	0	26	51	19	4
Ross	0	28.8	60.1	5.5	5.6
Strieter	1	25	43	31	0
	2	28	45	25	0
Weiss	0	20.0	51	28	1
Average	0.3	24.7	45.0	25.8	4.0
SAMPLE F					
Supposed Composition	5	30	30	30	5
Abraham	0	34	49	14	3
Berger	0	34	54.1	8.1	3.8
Codwise	1	31	54	12	2
Codwise (estimation method)	5	30	43	17	5
Hochstadter	2.3	38.1	39.5	9.4	9.6
Miller	3.4	30.6	53.6	8	4.1
Montgomery	10	20	50	10	10
Reeve	0	28	60	8	4
Ross	0.3	27.6	65.5	6.1	0.5
Strieter	trace	27	58	12	3
	trace	26	57	11	6
Average	2.0	29.7	53.1	10.5	4.6
SAMPLE G					
Supposed Composition	0	5	40	15	40
Abraham	0	6	42	21	31
Berger	0	5.6	43.1	18.6	32.7
Codwise	0	6	52	9	33
Codwise (estimation method)	0	10	45	10	35
Hochstadter	1	11.1	50.8	13.1	22.9
Miller	0.4	5.9	47.5	13.4	32.8
Montgomery	0	10	40	10	40
Reeve	0	5	55	6	36
Ross	0	25.5	67.2	4.8	2.5
Strieter	0	6	54	8	32
	0	8	52	13	27
Weiss	0	8	55	15	22
Average	0.1	8.9	50.3	11.9	28.9

TABLE I.—RESULTS OF COOPERATIVE TESTS ON ANALYSIS OF FELTS FOR FIBER COMPOSITION.—(*Continued*).

	Wool, per cent	Cotton, per cent	Chemical Wood, per cent	Mechanical Wood, per cent	Jute and Manila, per cent
SAMPLE H					
Supposed Composition	9.1	60.7	10.1	20.1	0
Abraham	0	55	11	34	0
Berger	3.6	63	9.8	23.6	0
Codwise	0	67	10	22	1
Codwise (estimation method)	0	65	15	20	0
Hochstadter	1.1	72.8	14.1	8	3
Miller	0.9	67.0	11.6	19.7	0.8
Montgomery	5	55	10	15	15
Reeve	0	73	11	14	2
Ross	0.6	75.7	19.7	0.2	3.8
Strieter	3	73	10	14	0
	3	71	10	16	0
Average	1.6	67.0	12.0	17.0	2.3
SAMPLE I					
Supposed Composition	0	10.3	20.5	40.8	28.4
Abraham	0	13	24	43	20
Berger	0	13.7	22.5	25.3	38.5
Codwise	0	12	30	36	22
Codwise (estimation method)	0	15	32	35	18
Hochstadter	0	2.2	30	42.6	24.3
Miller	0.5	16.3	26.4	23.0	33.8
Montgomery	0	10	25	40	25
Reeve	0	14	30	20	36
Ross	0	15.3	76.0	2.2	6.5
Strieter	0	15	27	32	26
	0	15	24	35	26
Average	0	12.9	31.5	30.4	25.1

Chemical Wood.—In all five samples the average results for chemical wood are higher than the supposed compositions. One cooperator is unusually high in all cases but even the elimination of his figures would not change the general result. This is true with both sulfate and sulfite pulp (compare samples E and G).

Mechanical Wood.—Average results run consistently low and especially low in sample F where wood flour was used instead of sawdust or pulp. The very fine wood flour is either lost during the making of the felt or missed to a large extent by the operators.

Jute and Manila.—Average results tend to be somewhat low.

The following tabular arrangement of results was made to indicate the extent of variation from the average of the different constituents, expressing the percentage variation in terms of the average result. For example, if the average result was 25 per cent, a 20 per cent variation represents results from 20 to 30 per cent inclusive.

		Average Percentage	Total Number of Tests	Tests Over 10 per cent from Average	Tests Over 15 per cent from Average	Tests Over 20 per cent from Average
Cotton	Sample E	25.0	12	7	4	1
	Sample F	30.0	11	5	2	2
	Sample H	67.0	11	4	2	0
	Sample I	13.0	11	8	5	1
Chemical Wood	Sample E	45.0	12	7	2	1
	Sample F	53.0	11	4	3	2
	Sample G	50.0	12	5	4	1
	Sample H	12.0	11	8	8	2
	Sample I	31.5	11	7	6	4
Mechanical Wood	Sample E	26.0	12	6	5	4
	Sample F	10.5	11	8	6	6
	Sample G	12.0	12	10	7	7
	Sample H	17.0	11	10	7	4
	Sample I	30.0	11	10	9	6
Jute and Manila	Sample G	29.0	12	11	7	5
	Sample I	25.0	11	7	6	5

In this tabulation any constituent less than 10 per cent has been omitted. It is evident that much better concordance was obtained with cotton and chemical wood than with either mechanical wood or jute and manila. It is also evident that it is not a good comparison to use any single arbitrary percentage variation since the more there is of a given constituent, the greater the actual percentage allowance and although as the actual percentage of a constituent increases, the allowable range of variation should increase, it is evident that this should not be a straight line relation. Accordingly, the following table was prepared, with the range of allowable variation considered as the square root of the average:

		Average Percentage	Square Root of Average	Total Number of Tests	Tests Over Square Root of Average from Average
Cotton	Sample E	25.0	5.0	12	1
	Sample F	30.0	5.5	11	2
	Sample H	67.0	8.1	11	1
	Sample I	13.0	3.6	11	1
Chemical Wood	Sample E	45.0	6.7	12	2
	Sample F	53.0	7.3	11	3
	Sample G	50.0	7.1	12	3
	Sample H	12.0	3.5	11	1
	Sample I	31.5	5.6	11	5
Mechanical Wood	Sample E	26.0	5.1	12	4
	Sample F	10.5	3.2	11	2
	Sample G	12.0	3.5	12	4
	Sample H	17.0	4.1	11	5
	Sample I	30.0	5.5	11	6
Jute and Manila	Sample G	29.0	5.2	12	5
	Sample I	25.0	5.0	11	5

TABLE II.—RESULTS OF SUBSEQUENT COOPERATIVE TESTS ON ANALYSIS OF FELTS FOR FIBER COMPOSITION.

	Wool, per cent	Cotton, per cent	Chemical Wood, per cent	Mechanical Wood, per cent	Jute and Manila, per cent	Unidentified Fibers, per cent
SAMPLE J						
Abraham	0	42.0	26.0	22.0	10.0	0
Berger	3.0	40.0	22.3	33.1	1.6	2.7
Kirschbraun	3.1	41.0	26.9	29.0	0.0	3.6
Marc	1.2	43.8	37.6	7.3	10.1	0
Miller	0.5	36.4	23.2	34.4	4.9	1.6
Montgomery	0	51.0	24.0	21.0	4.0	0
Strieter	0	40.0	19.0	41.0	0	0
Weiss	0.7	44.7	22.0	30.2	1.3	1.2
Young	0	41.0	31.0	28.0	0	2
Average	0.9	42.2	25.6	27.3	3.4	1.0
1927 Average	3.0	41.8	23.4	24.7	6.5	0.6
SAMPLE K						
Miller	1.6	40.4	13.8	24.1	19.7	0.4
Abraham	0	38.0	21.0	17.0	24.0	0
Berger	2.7	39.7	15.2	30.5	11.9	0
Kirschbraun	3.6	34.3	10.8	12.6	38.6	0
Marc	0	49.7	33.2	12.0	5.1	0
Montgomery	0	51.0	19.0	19.0	11.0	0
Strieter	0	38.0	12.0	32.0	18.0	0
Weiss	1.3	34.0	12.7	29.8	21.5	1.6
Young	2.0	39.0	20.0	28.0	11.0	0
Average	1.2	40.4	17.5	22.9	17.8	0.2
1927 Average	2.5	44.3	14.0	20.0	19.8	0.4
SAMPLE L						
Abraham	0	6.0	31.0	55.0	8.0	0
Berger	0	8.9	35.5	53.8	1.8	0
Kirschbraun	0	15.0	30.5	47.8	6.7	0
Marc	0	7.0	37.5	19.4	36.1	0
Miller	0.1	6.7	28.3	64.0	0.6	0.3
Montgomery	0	8.0	51.0	39.0	2.0	0
Strieter	0	6.0	24.0	70.0	0	0
Weiss	0	5.8	32.5	60.6	0.2	0.9
Young	0	9.0	37.0	54.0	0	0
Average	0	8.0	34.0	51.9	6.1	0.1
1927 Average	1.1	10.7	32.1	43.3	12.5	0.3
SAMPLE M						
Abraham	0	4.0	18.0	23.0	55.0	0
Berger	0	8.4	12.4	28.9	50.3	0
Kirschbraun	0	7.5	18.9	18.9	53.7	0
Marc	0	13.0	39.5	26.2	21.3	0
Miller	0.3	3.2	15.5	21.4	59.7	0.1
Montgomery	0	10.0	25.0	15.0	50.0	0
Strieter	0	7.0	14.0	38.0	41.0	0
Weiss	0.5	8.1	23.0	32.1	35.1	1.1
Young	0	13.0	22.0	39.0	24.0	0
Average	0.1	8.2	20.9	26.9	43.3	0.1
1927 Average	2.5	10.0	19.9	17.2	49.9	0.5

It is interesting to note that 89 per cent of the cotton results come within this limit while only 76 per cent of the chemical wood results do, with the mechanical wood at 63 per cent and the jute-manila 55 per cent. This will be discussed further after the next set of cooperative tests have been considered.

The next set of samples tested by the committee was sent out by the Bureau of Standards as samples J, K, L and M, respectively, and were the same felts as previously tested and reported in the 1927 report[1] as follows:

Sample J	Sample B of 1927 report
Sample K	Sample C of 1927 report
Sample L	Sample D of 1927 report
Sample M	Sample A of 1927 report

The supposed composition of these samples is as follows:

	SAMPLE J	SAMPLE K	SAMPLE L	SAMPLE M
Rag, per cent	50	60	10	10
Mixed Paper and Sawdust, per cent	50	25	90	30
Bagging, per cent	..	15	..	60

Nine laboratories submitted reports which are shown in Table II. The 1927 average results obtained by the committee and previously reported are included in this tabulation.

The following table was then prepared with the range of allowable variation as the square root of the average:

		Average Percentage	Square Root of Average	Tests Over Square Root of Average from Average
Cotton	Sample J	42.2	6.5	1
	Sample K	40.4	6.4	2
	Sample L	8.0	2.8	1
	Sample M	8.2	2.9	4
Chemical Wood	Sample J	25.8	5.1	2
	Sample K	17.5	4.2	3
	Sample L	34.0	5.8	2
	Sample M	20.9	4.6	3
Mechanical Wood	Sample J	27.3	5.2	5
	Sample K	22.9	4.8	6
	Sample L	51.9	7.2	5
	Sample M	26.9	5.2	4
Jute and Manila	Sample K	17.8	4.2	6
	Sample M	43.3	6.6	8

The relative variations and accuracy are of about the same order as before: 78 per cent of the cotton results being within the limits; 72 per cent of the chemical wood results; 45 per cent of the mechanical wood but only 22 per cent of the jute-manila. The same disappearance of wool is evident.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 521 (1927).

At this point it seems of interest to include the detailed results obtained in the chairman's laboratory on samples J, K, L and M as shown in Table III. This work followed exactly Method D 272 – 27 T except that each slide was made from a separate 0.1-per-cent dilution in order to see the concordance that could be expected, and to eliminate as far as possible sampling error.

TABLE III.—RESULTS OF ANALYSES IN CHAIRMAN'S LABORATORY.

	Total Fibers	Wool, per cent	Cotton, per cent	Chemical Wood, per cent	Mechanical Wood, per cent	Jute and Manila, per cent	Unidentified Fibers, per cent
SAMPLE J							
Slide 1	389	0.3	49.1	20.1	28.8	1.3	0.5
Slide 2	441	0.9	42.3	21.1	32.7	1.6	1.4
Slide 3	369	0.8	42.6	24.9	29.0	1.1	1.6
Average		0.7	44.7	22.0	30.2	1.3	1.2
SAMPLE K							
Slide 1	418	0.7	37.8	11.9	28.2	19.8	1.4
Slide 2	501	1.6	32.2	13.4	26.0	26.0	0.8
Slide 3	541	2.4	35.1	12.0	31.3	17.2	2.0
Slide 4	405	0.5	26.9[a]	13.6	33.6	23.2	2.2
Average		1.3	34.0	12.7	29.8	21.5	1.6
SAMPLE L							
Slide 1	401	0.2	4.3	25.4[a]	68.3	0	1.7
Slide 2	435	0	4.6	37.2	56.7	0.5	1.0
Slide 3	510	0	8.1	38.7[a]	53.1	0	0.4
Slide 4	609	0	6.4	28.8	64.4	0.2	0.3
Average		0	5.8	32.5	60.6	0.2	0.9
SAMPLE M							
Slide 1	424	0.7	8.5	26.9	23.8[a]	37.4	2.6
Slide 2	801	0.4	7.0	18.8	34.7	38.7	0.4
Slide 3	809	0.2	9.4	24.3	35.2	30.9	0.5
Slide 4	438	0.7	7.7	22.1	34.9	33.3	1.1
Average		0.5	8.1	23.0	32.1	35.1	1.1

[a] Outside variation of $\pm\sqrt{\text{Average}}$.

The slide results obtained agreed within the limits of plus or minus the square root of the average in all cases except four, which are indicated. In sample K the cotton on slide 4 was 1.3 per cent low; in sample L the chemical wood on slide 1 was 1.4 per cent low and on slide 4, 0.5 per cent high, and on sample M, slide 1, the mechanical wood was 2.6 per cent low. The indications are that with a sufficient count of fibers, error due to sampling within the limits of the especial sample of felt selected can be substantially eliminated.

This work also indicates the difficulty of (1) distinguishing mechanical wood from jute and manila, and (2) distinguishing some species of cotton fiber from chemical wood.

As to the first, it has been suggested that the development of an auxiliary differential stain to distinguish mechanical wood from jute and manila may be desirable and if possible the committee will have some work done along these lines.

The confusion between cotton and chemical wood is in the case of thin wood fibers and flat cotton fibers where the colors tend to approach each other. More attention will be given this in the future.

In the light of the foregoing work the sub-committee recommends certain changes in Methods D 272 - 27 T as indicated in the report of Committee D-8, designed to eliminate sampling errors and expects to continue cooperative work on the method.

Respectfully submitted on behalf of the sub-committee,

J. M. WEISS,
Chairman.

REPORT OF COMMITTEE D-9
ON
ELECTRICAL INSULATING MATERIALS

Three meetings, each of two days' duration, have been held by the committee and its sub-committees during the year, in addition to the one held during the annual meeting of the Society. The meetings held were as follows:

At Benjamin Franklin Hotel, Philadelphia, Pa., November 1 and 2, 1928;
At the Engineering Societies' Building, New York City, January 31 and February 1, 1929; and
At the Engineering Societies' Building, New York City, April 4 and 5, 1929.

As has been the custom in the past, the sub-committees have found that their work is greatly facilitated by having additional meetings at times other than those at which the main committee holds its meetings. The activities of the committee have been devoted to the development of new methods of testing insulating materials; to the improvement of the present standard or tentative standard methods; and to the development of specifications. The scope of the work is covered in detail in the following recommendations affecting standards and under activities of sub-committees.

RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS

Standard Methods of Testing Molded Insulating Materials (D48 – 27):[1]

During the past two years[2] the committee found it advisable to make definite recommendations relative to the method of testing molded insulating materials. The changes refer particularly to tension testing as applicable to hot-molding compounds, shellac compounds, pitch molding compounds, but not to silicate cold-molding compounds. They also refer to the dielectric strength specimen. These changes have proved that they are warranted and that they are a great improvement over the former methods of test. It is felt by the committee that, since neither the dielectric strength test specimen nor the tension test specimen as now described in the Standard Methods D 48 – 27 are used at all in the trade, it is imperative that the proposed revisions be advanced to standard. The committee therefore recommends that the tentative revisions recommended during the past two years and published collectively in 1928[1] be advanced to standard.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 785.

[2] See *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 525 (1927); also Vol. 28, Part I p. 564 (1928).

Continued experience with the methods of test for molded materials has brought out certain points that should be improved. The items in question apply particularly to the method of molding the compression test specimen and the water absorption specimen. As a result of this experience it is also recommended that the following additional revisions be adopted immediately.[2] The committee accordingly asks for the necessary nine-tenths vote at the annual meeting for submission of these revisions to the Society for immediate adoption.

Section 7.—It is recommended that the following note be added to this section in explanation of molding the particular cylinder:

> NOTE.—Due to the size and shape of this specimen, it is sometimes difficult to completely cure it within the relatively short time which would ordinarily be used and with the temperatures ordinarily used. This is particularly true when hand molds, that is, molds heated by conduction from the press platens, are used. It is, therefore, recommended that special precautions be taken to insure thoroughly cured parts, experiments indicating that 20 to 30 minutes are necessary for hand molds.

Section 10.—Change the last sentence to read as follows by the addition of the italicized words:

> The load shall be applied, ***parallel to and in the same direction that the molding pressure was applied***, midway between the supports by a pressure piece, the bearing edge of which shall be rounded to a radius of ⅛ in. (3.18 mm.).

Section 22.—The conditions under which the water absorption test has been made have been found to be somewhat unsatisfactory and can be improved. It is therefore recommended that this section be changed from its present form: namely,

> 22. Any good chemical balance, a beaker of water at normal room temperature of about 20° C. (68° F.) and an oven of any standard make capable of maintaining a uniform temperature of 100° C. (212° F.), with a variation allowed of ± 5° C.

to read as follows:

> 22. Any good chemical balance, a beaker of water at 25° C. ± 5° C. (77° F. ± 9° F.), and an oven of any standard make capable of maintaining a uniform temperature of 100° C. ± 5° C. (212° F. ± 9° F.).

Section 23.[2]—Change from its present form: namely,

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1130 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 862.

[2] On recommendation of the committee, the revision of Section 23 was accepted for publication as tentative only.—ED.

23. The test specimen No. 3 shown in Fig. 2 (the accompanying Fig. 1) shall be used for this test.

to read as follows:

23. The test specimen shall be molded in the form of a disk 4 in. (10.16 cm.) in diameter which should be $\frac{1}{8}$ in. (3.18 mm.) in thickness for hot-molded materials, and $\frac{1}{4}$ in. (6.35 mm.) in thickness for cold-molded materials.

Fig. 2.—The revision of Section 23 will necessitate the omission of Fig. 2 (the accompanying Fig. 1).

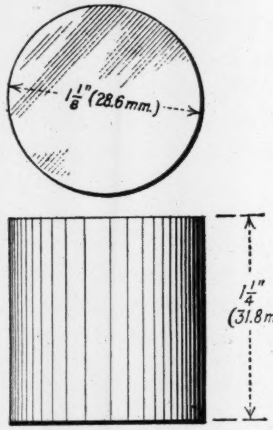

FIG. 1.—Compression Test Specimen.
(Specimen No. 3.)

Section 24.—Change from its present form: namely,

24. Three specimens shall be tested. Each of the three shall be weighed separately in the as-received condition. If the material softens readily at moderate temperatures, the specimen may be placed in a desiccator for 24 hours, or in an oven at a temperature at 50° C. (122° F.), permissible variation ± 5° C., for 24 hours. For materials which do not soften readily, the specimen shall be placed in an oven heated to 100° C. (212° F.), permissible variation ± 5° C., for 24 hours. After drying, the pieces shall be cooled in a desiccator and weighed again at normal room temperature. The specimens shall be placed in water, wholly immersed, for 48 hours at normal room temperature. They shall then be removed from the water at the end of 48 hours, all surface water wiped off with a dry cloth, and the specimens weighed immediately.

to read as follows:

24. Three specimens shall be tested. Each of the three shall be weighed separately in the as-received condition. If the material softens readily at moderate temperatures, the specimen may be placed in a desiccator for 24 hours, or in an oven at a temperature of 50° C. ± 5° C. (122° F. ± 9° F.), for 24 hours. For materials which do not soften readily, the specimen shall be placed in an oven heated to 100° C. ± 5° C. (212° F. ± 9° F.), for 24 hours. After

drying, the specimens shall be cooled in a desiccator and weighed again at normal room temperature. The specimens shall be placed in water, wholly immersed, for 48 hours at a temperature of 25° C. ± 5° C. (77° F. ± 9° F.). They shall then be removed from the water at the end of 48 hours, all surface water wiped off with a dry cloth and the specimens weighed immediately.

Standard Methods of Testing Electrical Insulating Oils (D 117 - 27):[1]

In last year's report it was stated that the International Electrotechnical Commission's standard for sampling insulating oil was being considered by the committee. This method has been slightly changed and made international. A study of the method by Sub-Committee IV revealed that it would be desirable to have some of the revisions and additions incorporated in the A.S.T.M. Standard Methods D 117. In rewriting the method to incorporate these changes, it is observed that a number of other minor changes should be made in order to make the method more complete. Experience with the test during the year has also revealed improvements that could be made and these are embodied in the revision which has been made by the sub-committee to cover the section on sampling in Methods D 117. The sub-committee feels that the method as rewritten will be acceptable to the I.E.C., as the committee has incorporated practically all of the suggestions made by the I.E.C. It is, therefore, recommended that the sections on sampling as given in the Appendix to this report[2] be accepted for publication as a tentative revision of the present Sections 1 to 7, inclusive, of the Standard Methods D 117 - 27.

Tentative Methods of Testing Insulating Varnishes (D 115 - 28 T):[3]

In last year's report mention was made of the fact that up to that time the present method of determining drying time of varnish, using a copper base, seemed to be the most sensitive test. Investigations during the past year have shown that changes can be made in this method of test which eliminate all personal element and reduce the test to a mechanical measurement. A new procedure is being proposed which reduces the determination of drying time to the basis of a unit pressure per unit area per unit time, being based upon the E.R.A. principle (British Electrical and Allied Industries Research Association). Use is made of a coated copper strip with a plain strip of kraft paper.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 796.

[2] See p. 457.—ED.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 975 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 594.

There were a number of other sections of these methods which were somewhat vague and indefinite. Studies during the year have led to changes which are believed to be desirable and which will make the methods more satisfactory. The committee accordingly recommends that these methods be revised as follows and continued as tentative. The methods as revised are believed to be specific in all details.

Section 5 (b).—Change the second sentence to read as follows by the addition of the italicized word and figures and the omission of those in brackets:

The consistency of the varnish shall be first so adjusted by trial that, when dry as determined in accordance with Section 7, the *average* thickness of the film of varnish on each side of the metal shall be between [0.022 mm. (0.0009 in.) and 0.026 mm. (0.001 in.)] *0.022 and 0.026 mm.* (*0.0009 and 0.001 in.*).

Section 6.—Add to this section a note reading as follows:

NOTE.—The size of oven and the amount of ventilation have a considerable effect on the drying time of varnishes. For this reason the analytical type of electrically-heated oven should be used.

Section 7.—Change from its present form: namely,

7. The varnish shall be considered dry when a specimen will not stick to itself when folded and pressed together between the thumb and finger at a temperature of approximately 20° C. (68° F.).

to read as follows:

7. *Time of Drying.*—The varnish shall be considered dry when a piece of kraft paper 38 mm. (1.49 in.) in width and 152 mm. (6 in.) in length and approximately 0.063 mm. (0.0025 in.) in thickness does not adhere to the varnish when it is pressed on the surface of the varnish for one minute by a cylindrical 1-lb. weight, 1 in. in diameter. The kraft paper shall be applied in the vicinity of the center of the specimen and at right angles to it. The test shall be made at a temperature of approximately 20° C. (68° F.).

NOTE.—Certain types of varnishes dry with what is commonly known as a "tack"; but these types are rare. However, when testing them for drying time, it will be found that the kraft paper adheres to the varnish film and offers a certain amount of resistance to removal. On continued drying, the resistance to removal reaches constancy and is not changed by further drying. Therefore, the drying time is reported as the number of hours required to first reach constancy and the varnish should be reported as drying with a "tack."

Section 8 (c).—Change to read as follows by the addition of the italicized words and the omission of the figures and words in brackets:

(*c*) Specimens of air-drying varnish shall be dried in dust-free air after each dip at a room temperature of approximately 20° C. (68° F.) for a period [600 per cent longer than] *six times as long as* that determined in accordance with Section 7[, provided such period does not exceed 24 hours].

Change Paragraph (*d*) to read as follows by the addition of the italicized words and the omission of the words and figures in brackets:

(*d*) Specimens of baking varnish shall be drained and then baked in dust-free air after each dip for a period [300 per cent greater than] *three times as long as* that determined in accordance with Section 7[, provided such period does not exceed 24 hours].

Sections 13 and 14.—Change the Heat Endurance Test from its present form: namely,

HEAT ENDURANCE TEST

13. (*a*) For the heat endurance test, specimens shall be prepared by dipping pieces of thoroughly cleaned, smooth sheet copper or brass about 20 cm. (7.88 in.) square and about 0.127 mm. (0.005 in.) thick into the varnish which shall be at the consistency prescribed in Section 5 (*b*).

(*b*) The specimens shall be dipped twice as prescribed in Section 5 (*b*).

(*c*) After removing not less than 1.27 cm. (0.5 in.) from one edge of the specimens the number of strips required by Section 14 (*a*) shall be cut from the same edge each 1.9 cm. (0.75 in.) in width.

14. (*a*) After setting as shown by the test indicated in Section 6 (*b*), the strips referred to in Section 13 shall be placed in a uniformly heated oven in which the temperature is maintained at 100° C. (212° F.) within ± 5° C. (9° F.). A strip shall be removed at the end of 1, 2, 4, 8 and 24 hours respectively and every 24 hours thereafter. These, together with the initial strip, shall be tested as follows at a room temperature of approximately 20° C. (68° F.).

(*b*) Each strip shall be bent through 180 deg. over a rod 0.32 cm. ($\frac{1}{8}$ in.) in diameter. The number of hours of baking at which first cracking in the insulation occurs shall be noted and reported.

to read as follows:

HEAT ENDURANCE TEST

13. (*a*) *Test Specimens.*—Specimens shall be prepared by dipping pieces of thoroughly cleaned, smooth sheet copper or sheet brass about 20 cm. (7.88 in.) in length, 3 cm. (1.18 in.) in width and 0.127 mm. (0.005 in.) in thickness, into the varnish. The consistency of the varnish shall previously be adjusted by trial so that, when dry as determined in accordance with Section 7, the thickness of the film of varnish on each side of the metal shall average between 0.022 and 0.026 mm. (0.0009 and 0.001 in.).

(*b*) Each specimen shall be dipped in the varnish at room temperature of approximately 20° C. (68° F.) and withdrawn slowly and uniformly (about 38 cm. (15 in.) per minute). The varnish shall be allowed to dry in the air (if an air-drying varnish) or baked in an oven at 105 to 110° C. (221 to 230° F.) (if a baking varnish) until dry as determined in accordance with Section 7. As soon as the first coat of varnish is dry, and the specimen is at room temperature, it shall be dipped again in the varnish in the reverse direction so as to give a uniform thickness of coating. The second coat of varnish shall be allowed to dry in the same manner as the first coat. When the second coat of varnish is dry, the specimen shall be measured. The thickness of varnish on each side of the metal shall be between 0.044 and 0.052 mm. (0.00173 and 0.00205 in.).

14. (*a*) *Procedure.*—The specimens shall be placed in a uniformly-heated oven, in which the temperature is maintained at 105 to 110° C. (221 to 230° F.). A specimen shall be removed at the end of the first 24 hours and every 24 hours thereafter.

(*b*) Each specimen, after heating, shall be tested at room temperature of approximately 20° C. (68° F.) by bending it through 180 deg. around a rod 0.32 cm. (0.125 in.) in diameter.

15. *Report.*—The number of hours of baking of the specimen which first showed cracking of the varnish film shall be reported, together with the make and type number of the oven used.

NOTE.—The size of oven and the amount of ventilation have a considerable effect on the heat endurance of varnish films. For this reason the analytical type of electrically-heated oven should be used.

Sections 15, 16 and 17.—The method for Acid and Alkali Proof Test has not seemed to work out satisfactorily, and pending the revision of this method, it is recommended that the present Sections 15, 16 and 17 on Acid and Alkali Proof Test be omitted. This will require renumbering the subsequent sections accordingly.

Section 19.—Change to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

19. The effect of oil on the varnish shall be determined by immersing the specimens in transformer oil at a temperature of [100° C. (212° F.)] *105 to 110° C. (221 to 230° F.)* for 48 hours and noting the effect on the varnish as indicated, for example, by wiping with a dry piece of white cloth.

NOTE.—Incipient disintegration of the surface of the varnish may sometimes be detected by examining the oil for turbidity. If a specimen of the *used* oil filtered through filter paper can be distinguished from an unfiltered sample *of the used oil,* when the two samples, *in identical containers,* are held in front of a [strong] *diffused* light, the oil is turbid.

Section 25.—Change the heading of this section from "Test for Non-Volatile Matter" to read "Tests for Non-Volatile Matter by Weight."

Section 26.—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

26. The ratio of the weight of the residue to [that of] *the weight of* the original sample expressed as a percentage shall be taken as the percentage of non-volatile matter *by weight* in the varnish.

Appendix, Section 1.—Change Paragraph (*c*) to read as follows by the addition of the italicized words and the omission of the words and figures in brackets:

(*c*) Specimens of air-drying varnish are dried in free air after each dip at a room temperature of approximately 20° C. (68° F.) for a period [600 per cent longer than] *six times as long as* that determined in accordance with Section 7 of the methods[, provided such period does not exceed 24 hours].

Change Paragraph (*d*) to read as follows by the addition of the italicized words and the omission of the words and figures in brackets:

> (*d*) Specimens of baking varnish are drained and then baked after each dip for a period [300 per cent greater than] *three times as long as* that determined in accordance with Section 7 *of the methods*[, provided such period does not exceed 24 hours].

Tentative Methods of Testing Electrical Porcelain (D 116 – 28 T):[1]

The section on scope of these methods does not definitely specify whether the specimens used in the various tests should be glazed or unglazed. It has been generally understood, however, that the methods were intended to apply to unglazed porcelain. Tests conducted during the past indicate that the glaze affects the mechanical strength. It is believed that this effect is due to the manner in which the glaze "fits" the porcelain body. It is, therefore, suggested that some reference be made to this fact in a note to the section on scope. The following revision in Section 1 is accordingly recommended:

Section 1.—Change from its present form: namely,

> 1. These tests are intended to apply to porcelain which is to be used for electrical insulating purposes.

to read as follows:

> 1. These methods are intended to apply to porcelain which is to be used for electrical insulating purposes. Specimens for purpose of tests shall be unglazed.
>
> NOTE.—Tests on porcelain are made on unglazed specimens since it is desired to determine the strength of the porcelain structure only. Tests have indicated, however, that the glaze may have an effect on the mechanical strength. In some cases the values obtained are higher, and in other cases, lower than obtained on unglazed specimens. It is believed that this difference is due to the fact that the glaze may not "fit" the porcelain uniformly and therefore cause stresses to be set up within the porcelain body. Mechanical strength tests on unglazed and glazed specimens may therefore be of value as giving an indication of the "fit" of the glaze to the porcelain body.

Tentative Methods of Testing Cable Splicing and Pothead Compounds (D 176 – 25 T):[2]

The committee recommends the following revisions in these methods:

Section 4. (*b*).—Change the last sentence to read as follows by the addition of the italicized figures and the omission of those in brackets:

> It is therefore recommended that a sufficient number of tests be made at different temperatures to establish the momentary dielectric strength – temperature curve from [–25° C.] *0° C.* to + 100° C.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 985 (1928); also 1928 Book of A.S.T.M Tentative Standards, p. 604.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part I, p. 810 (1925); also 1928 Book of A.S.T.M. Tentative Standards, p. 635.

Section 6.—Change from its present form: namely,

6. (*a*) In the case of materials which are hard at room temperature, they shall be tested between hemispherical electrodes embedded therein which are ½ in. in diameter separated by a gap of 0.1 in.

NOTE.—A convenient form of apparatus for holding the electrodes and compound is described in the Appendix.

(*b*) In the case of materials which are soft at room temperature, they shall be tested between polished brass or copper circular disk electrodes, 1 in. in diameter and having a square edge, the electrodes to be placed with their axes horizontal and coincident and with a gap of 0.1 in. between their adjacent faces.

NOTE.—This test can be made with the apparatus normally used for testing transformer and switch oils. (See the Standard Methods of Testing Electrical Insulating Oils (Serial Designation: D 117) of the American Society for Testing Materials.)

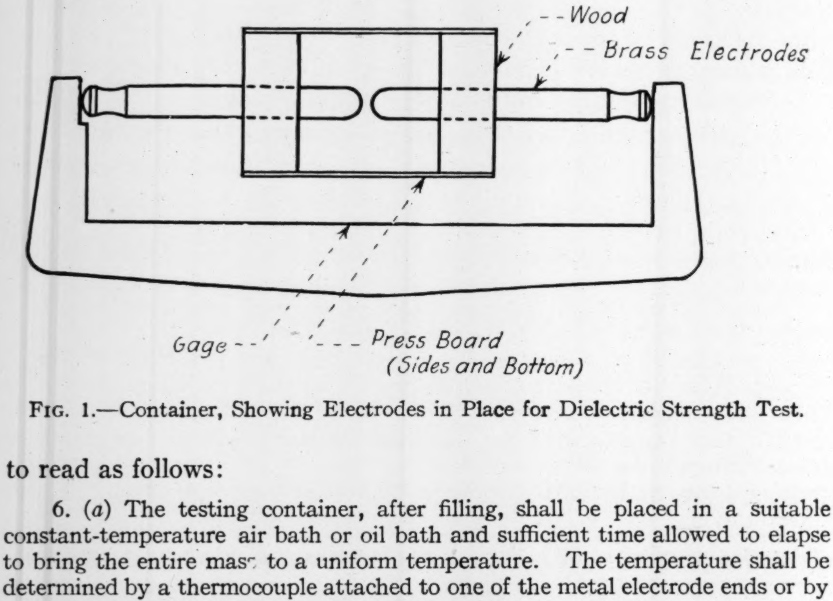

FIG. 1.—Container, Showing Electrodes in Place for Dielectric Strength Test.

to read as follows:

6. (*a*) The testing container, after filling, shall be placed in a suitable constant-temperature air bath or oil bath and sufficient time allowed to elapse to bring the entire mass to a uniform temperature. The temperature shall be determined by a thermocouple attached to one of the metal electrode ends or by a mercury thermometer placed vertically touching an electrode and approximately ½ in. (1.25 cm.) from the gap between electrodes.

(*b*) The test shall be made between polished hemispherical (Note 1) brass or copper electrodes ½ in. in diameter separated by a gap of 0.1 in. (Note 2).

NOTE 1.—A convenient form of apparatus for holding the electrodes and compound is described in the Appendix. It is recognized that when liquid materials are being tested, this method is inconsistent with the Standard Methods of Testing Electrical Insulating Oils (A.S.T.M. Designation: D 117) of the American Society for Testing Materials. However, since spherical electrodes are considered preferable for solid and semi-solid materials, the advantage of using spherical electrodes for all splicing compounds, whether

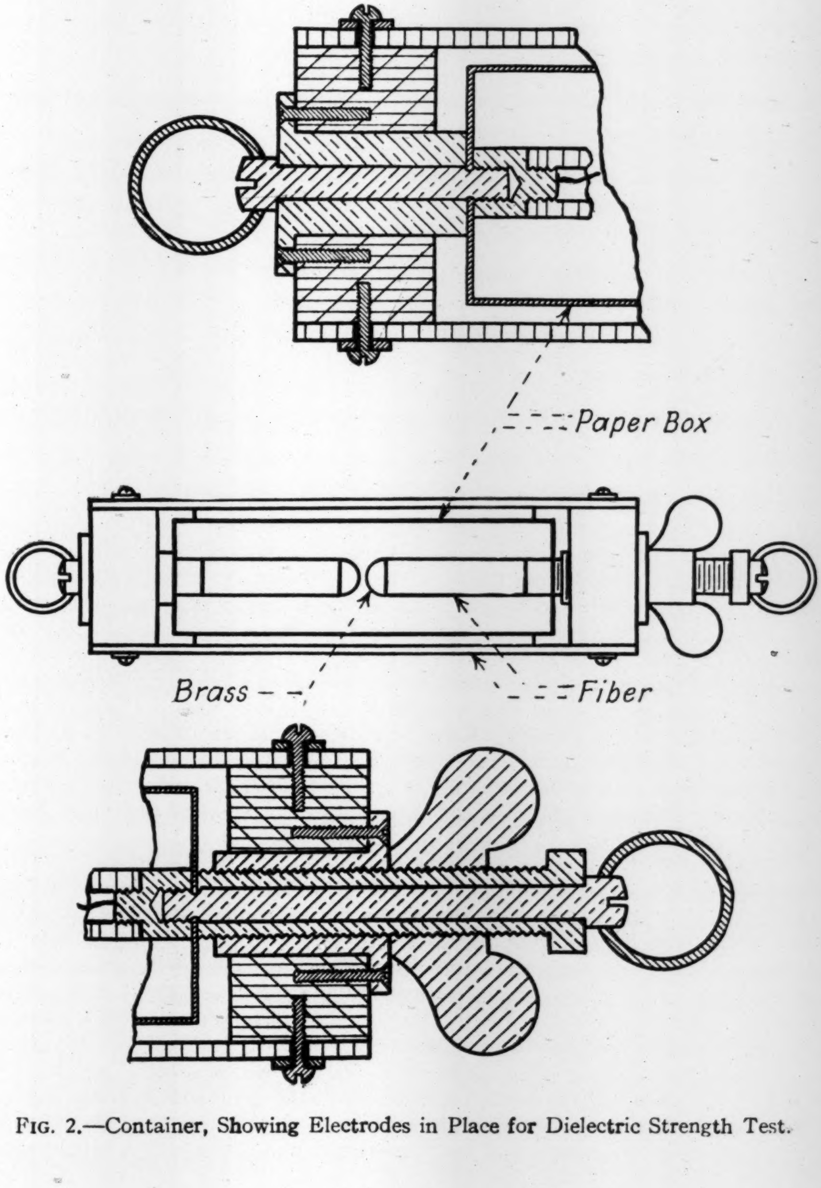
Paper Box
Brass
Fiber

FIG. 2.—Container, Showing Electrodes in Place for Dielectric Strength Test.

liquid or solid, so that direct comparison can be made, is sufficiently great to justify the inconsistency with the Standard Methods D 117.

NOTE 2.—In the case of materials which cannot be broken down with the available voltage, the gap may be reduced to 0.05 in. but results will not be comparable directly with those obtained with the 0.1-in. gap.

Section 7.—Designate the present section as Paragraph (*a*) and add a new Paragraph (*b*) to read as follows:

(*b*) The actual gap at the test temperature shall be determined by direct measurement or by measurement at some other temperature and computation of changes due to expansion or contraction.

Section 9.—Change Paragraph (*b*) to read as follows by the addition of the italicized words:

(*b*) The individual values of the puncturing voltage *and the gap length* at the various temperatures.

Appendix.—Omit the present appendix and substitute in its place the following:

APPENDIX

Because of the great difficulty experienced in removing most cable splicing and pothead compounds from the container and from the electrode an arrangement is desirable which is sufficiently inexpensive to permit of it being discarded fully or in part after the test. Two devices that have proved satisfactory are illustrated in Figs. 1 and 2.

Figure 1 shows the simplest device. It consists of a box about 2 in. square in cross-section and 2 in. in length inside of the wooden ends. The sides and bottom are made from a single piece of press board and are attached to wooden blocks which form the ends. Holes drilled through the wooden blocks receive the electrodes which are turned from $\frac{1}{2}$ in. diameter brass rod. To facilitate adjustment of the gap length, a gage is arranged to slip over the ends of the electrode and so regulate the gap to the desired value.

Figure 2 shows a more elaborate type of testing device consisting of a framework made from laminated phenol fiber about 8 in. (20 cm.) in length and $2\frac{1}{4}$ in. (5.7 cm.) square with brass bushings centrally inserted in each end member to hold the electrode rods. A box of heavy paper or pasteboard is arranged to fit loosely inside the framework. The electrodes, which are separable by means of screw joints, are inserted through small holes in the ends of the paper box and clamped to make an oil-tight joint. The proper electrode spacing may be obtained by means of an adjusting screw on the right-hand end. Changes in the electrode spacing with temperature can be reduced greatly (to less than 0.001 in. in a change of temperature of 75° C.) by the indicated electrode design. Phenol fiber of suitable coefficient of expansion is used for supporting the brass hemispherical electrode tips and electrical connection is made by a copper wire through the center of the fiber rod. The volume of the container may be reduced to accommodate small samples by the insertion of wedges of carefully dried wood into the corners of the paper box.

Tentative Methods of Testing Untreated Insulating Paper (D 202 - 28 T):[1]

Experience gained through the use of this method during the past year has developed certain minor changes which it is desirable be incorporated in the present tentative method. It is therefore recommended that the following changes or additions be made:

Section 3.—Change the last sentence to read as follows by the addition of the italicized words:

> The following physical tests shall be made in the conditioned air: tensile breaking strength, tearing strength, bursting strength, folding endurance, air resistance, *dielectric strength*, and thickness.

Section 32 (b).—Change the fifth sentence by the addition of the italicized figures and the omission of those in brackets:

> It shall weigh, including the flat ring clamp and the two knurled nuts, [567 g. (20 oz.) ± 5 g. (0.18 oz.)] *567 g. ± 0.5 g. (20 oz. ± 0.018 oz.).*

Section 35.—In order that some definite idea may be obtained as to the accuracy in air-resistance determinations, it is recommended that the following table be added to this section as an explanatory note:

> NOTE.—The following values show the probable accuracy obtainable in the air-resistance tests:

AIR RESISTANCE	ACCURACY
40 seconds	± 5 per cent
100 seconds	± 6 per cent
200 seconds	± 8 per cent
300 seconds	± 10 per cent

At the present time there are no requirements to the methods of testing insulating paper to cover the determination of the dielectric strength. In order that such requirements may be included it is recommended that a new Section 48 on dielectric strength be added, and that the present Section 48 be changed to Section 49, the new section to read as follows:

> 48. *Dielectric Strength.*—The dielectric strength shall be determined in accordance with the Tentative Methods of Testing Sheet and Tape Insulating Materials for Dielectric Strength (A.S.T.M. Designation: D 149 - 27 T) of the American Society for Testing Materials.

Tentative Methods of Test for Surface Resistivity and Volume Resistivity of Solid Insulating Material (D 257 - 26 T):[2]

The committee believes it desirable to include in these methods, a method for determining the resistivity of liquids. The methods have accordingly been completely rewritten as appended hereto.[1] It is recommended that the revised methods be accepted for publication as tentative.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 998 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 640.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 1059 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 668.

Tentative Methods of Testing Varnished Cloth Tapes (D 295 - 28 T):[2]

In order to make the methods of testing varnished cloth tapes applicable to varnished cloths, the methods have been rewritten so as to embody the necessary changes. It is recommended that the proposed methods appended hereto[3] be accepted for publication as tentative.

The following is the result of the letter ballot vote of the committee, which consists of 52 members, on the recommendations made in this report:

Items	Affirmative	Negative	Not Voting
I. PROPOSED REVISIONS OF STANDARDS			
Standard Methods of Testing Molded Insulating Materials (D 48 - 27), immediate adoption	26	0	19
Standard Methods of Testing Electrical Insulating Oils (D 117 - 27)	28	0	16
II. PROPOSED REVISIONS OF TENTATIVE STANDARDS			
Tentative Methods of Testing Insulating Varnishes (D 115 - 28 T)	27	0	17
Tentative Methods of Testing Electrical Porcelain (D 116 - 28 T)	19	0	26
Tentative Methods of Testing Cable Splicing and Pothead Compounds (D 176 - 25 T)	25	0	20
Tentative Methods of Testing Untreated Insulating Paper (D 202 - 28 T)	32	0	13
Tentative Methods of Test for Surface Resistivity and Volume Resistivity of Solid Insulating Materials (D 257 - 26 T)	27	0	16
Tentative Methods of Testing Varnished Cloth Tapes (D 295 - 28 T)	24	0	18

SUB-COMMITTEE ACTIVITIES

Sub-Committee I on Insulating Varnishes (V. A. Ryan, chairman)—In addition to the work that has been done on heat endurance, drying time, and in the general reviewing and revising of Methods D 115 - 28 T as outlined in the earlier part of this report, this sub-committee has been actively investigating several other subjects:

(*a*) Studies are being made to work out a suitable method for measuring the dielectric strength of insulating varnishes at elevated temperatures. So far the results lead to the hope that something definite will be worked out shortly.

(*b*) Methods of measuring the hardness of varnish films and of oil resistance to film hardness are being studied. A rather promising method of scratching varnished surfaces has been developed by the Westinghouse Electric and Mfg. Co. in connection with this problem.

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[1] See p. 773.—ED.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1026 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 680.

[3] See p. 786.—ED.

Future studies will determine the adaptability of the apparatus in connection with these determinations.

(*c*) Up to the present time, the studies of the acid and alkali proof test have not led to very promising suggestions. It is likely that this subject will be continued, however.

Sub-Committee II on Molded Insulating Materials (A. M. Lynn, chairman).—In addition to the investigations by this subcommittee which have led to the recommendations for revision of Methods D 48 – 27, as given earlier in the report, this group is actively engaged in studies along several other lines.

During the past year studies have been made on the compression test specimen, and while they have not led to a change in the method of making this test, they have led to the conclusion that for the present there will be no change made in the compression test specimen. Its shape is correct and its relative length as compared to the diameter is fairly satisfactory.

Considerable progress has been made during the past year in connection with the methods of testing for the plasticity of phenol plastic molding compounds. As this type of test leads to a rather expensive type of equipment and, since the number of interested parties is not so large, the progress has been relatively slow.

In connection with the studies on impact, two different lines have been under consideration. In one of these, attempts are being made to broaden the present method by determining whether comparable results cannot be obtained for pieces of different thicknesses. The Bakelite Corporation has found that quite comparable results can be obtained for pieces of different thicknesses, if the energy to break the specimen is divided by the square of the thickness times the width of the specimen. Comparative studies will be made on this subject by different laboratories with the idea of checking the Bakelite Laboratory's results. If these results do check satisfactorily, it will lead to a method of expressing the energy to break in a slightly different way.

Studies to determine the effect of impact fatigue have been under way for some little time and will doubtless be pushed more actively during the coming year. It is hoped that these studies will lead to definite information as to the effect of repeated impact upon the actual energy to break a given specimen.

During the past year preliminary studies have been started to draw up purchase specifications for resoid plastic molding compounds and resoid plastic molded products. This work will likely be continued.

Sub-Committee III on Sheet Insulation (Dean Harvey, chairman). —This sub-committee, working on sheet insulating materials, has developed several recommendations as a result of its studies. There are quite a number of subjects in which this committee is carrying on active work:

(*a*) *Gaging of Insulating Materials.*—In order to correlate the various methods by means of which thicknesses are measured for thin materials, a special section of Sub-Committee III has been organized to go into this subject. This question has been up for some time and since it affects a relatively large number of methods of test, it is desirable that some coordination be worked out among the different methods by means of which thicknesses are determined.

(*b*) *Insulating Paper.*—As a result of experience gained through use of the Tentative Methods of Testing Untreated Insulating Paper (D 202 - 28 T), certain revisions are being recommended as mentioned earlier in the report. Comparative thickness measurements have been progressing nicely on samples of several different thicknesses using different types of micrometers. This material will be valuable for the special committee mentioned above. An edge tearing tester is being tried out by several different laboratories.

(*c*) *Laminated Sheets.*—Preliminary work has been started in drawing up purchase specifications for phenol fiber sheets and hard sheet fiber. This work will be continued during the coming year and will probably lead to definite recommendations.

(*d*) *Thermal Conductivity.*—Additional samples of a rubber-graphite composition have been prepared by the U. S. Bureau of Standards as proposed standard specimens. These will be measured by different laboratories to check the present flat plate method with the simpler method now being tried. This latter method consists of using one of these special sheets as a standard.

(*e*) *Dielectric Tests.*—The section working on the dielectric strength of materials has been developing a method of test at high temperatures. This work will be continued during the year.

(*f*) *Varnished Cloth and Varnished Cloth Tubing.*—In order to make the Tentative Methods of Testing Varnished Cloth Tape (D 295 - 28 T) applicable to varnished cloth, this method has been rewritten, as mentioned earlier in the report. Preliminary drafts of a method of testing varnished cloth tubing and preliminary specifications for varnished cloth have been prepared.

(*g*) *Starting New Subjects.*—In order to obtain best results and to guarantee that subjects which are brought up are deserving of serious consideration, the sub-committee has decided that hereafter very thorough investigations will be made of the desirability of the studies before actually taking them up. It is hoped in this way that it will be possible to avoid carrying on a large series of investigations and finding later that the interest in the particular problems is very limited.

Sub-Committee IV on Liquid Insulation (E. A. Snyder, chairman).—While the work on liquid insulation during the past year has led to only one recommendation relative to the method of sampling oil, there has been considerable work done along various lines. At the present time the work of the sub-committee is divided into groups working on the following subjects: (*a*) Neutralization Value, (*b*) Life Test, (*c*) Short-Time Sludge Tests, (*d*) Tests for Circuit Breaker Oils, (*e*) Sampling Oil from Apparatus in Service, (*f*) Correlation of Work on Insulating Oils of the International Electrotechnical Commission with the activities of Sub-Committee IV.

(*a*) *Neutralization Value.*—The work of developing suitable electrometric methods for measuring neutralization number of insulating oils has been progressing steadily during the year and the section is now ready to prepare several alternate methods on which to conduct a series of comparative tests by five or six cooperative laboratories.

(*b*) *Life Test.*—Through cooperative tests carried on by members of this section on identical samples of oil and also through cooperative tests by the Transformer Oil Advisors Committee of the International Electrotechnical Commission, the membership of which committee overlaps largely the membership of Sub-Committee IV, it has been proved that good check results can be obtained by different laboratories if strict attention is paid to carrying out the specifications of the test. Check results obtained in these investigations have been better with the life test method than with any of the sludge test methods so far investigated by this committee. From work that has been done during the past year, it has been concluded that the first appearance of sludge is not always a true indication of the stability of the oil in service. Furthermore, it is felt that the life test should include a suitable scheme for measuring the rate of sludge accumulation for a definite period after the first appearance of sludge, and efforts are being extended along this line. The study of developing a sludge accumulation test involves several problems such as: (1) obtaining representative samples from the sludged oil; (2) accurately determining the amount of sludge in such a sample; (3) the effect of evaporation of the oil sample in the life test over a long period of time, thus changing the character of the oil in respect to its ability to hold sludge in solution.

It has been shown that some types of oil are extremely sensitive to temperature and are therefore quite unstable at 120° C., which is the temperature of the life test, but are quite stable at transformer operating temperatures. If further studies confirm this to be a general fact in regard to oils, it will have quite a bearing upon the development of a suitable sludge test. This point will be further investigated during the coming year.

(*c*) *Short-time Sludge Test.*—The sub-committee realizes that one big objection to the life test and many of the other sludge tests which it has studied, is the fact that it requires too long a period of time to obtain results. The section on short-time sludge tests has, therefore, been reviewing the possibilities of using various types of accelerated sludge tests. The sub-committee has nothing definite to recommend as yet but proposes to carry on this work vigorously during the coming year.

(*d*) *Methods of Test for Circuit Breaker Oils.*—Conditions of service for circuit breaker oils show that certain tests additional to those used for transformer oils are necessary to differentiate between different circuit breaker oils. In addition to the tests applied to transformer oils the sub-committee is actively engaged in studying tests for resistance to emulsification, retention of water, formation of gases under arcing temperature, and rate of settling out of carbon.

(*e*) *Sampling Oil from Apparatus in Service.*—The sub-committee, realizing that in most types of electrical apparatus suitable provisions are not made for obtaining a representative sample of the insulating oil, has tabulated a report obtained from circulating a questionnaire on this subject, which will be presented by Committee D-9 to the Executive Committee of the Society for presentation to such organizations of manufacturers of electrical apparatus as may be interested, for their study and comment.

(*f*) *Correlation of Work of International Electrotechnical Commission on Insulating Oils with Activities of Sub-Committee IV.*—The work in connection with this subject has led to the development of a method of sampling, as mentioned earlier in this report, for adoption as a tentative revision of the present Standard Methods of Testing Insulating Oils (D 117 - 27).

This group during the past year translated and circularized to interested members of the committee and also to members of the transformer oil advisors group of the I.E.C., papers on the subject of insulating oils as presented at the last international meeting of the I.E.C. and also papers that were presented at the International Congress for Testing Materials. This work of translating and distributing papers of this type has been of considerable help and interest to all who are interested in insulating oils.

Sub-Committee V on Porcelain Insulation (L. E. Barringer, chairman).—As mentioned earlier in the report, this sub-committee is recommending certain slight revisions in the Tentative Methods of Testing Electrical Porcelain (D 116 - 28 T).

Sub-Committee VI on Cable Splicing and Pothead Compounds (W. F. Davidson, chairman).—As mentioned earlier in this report, this sub-committee is recommending revisions in the Tentative Methods of Testing Cable Splicing and Pothead Compounds (D 176 - 25 T).

The sub-committee has given much consideration to the several phases of the methods as they exist at the present time, and investigations show that there are several ways in which they can be improved. After careful study the tentative methods have been revised and recommendations have been made in accordance with the findings.

The section on dielectric strength test of these methods has been revised to include:

1. A statement as to the means to be used for determining temperature.
2. The elimination of the oil test cup for liquid materials as these appear to be covered adequately by the test for insulating oils.
3. Provision for a gap of 0.05 in. where materials cannot be broken down with the standard 0.1-in. gap.
4. A revision of the appendix to describe two types of test cup which have proved more satisfactory than the form previously described.

Sub-Committee VII on Radio Frequency Tests (E. S. Lee, chairman).—This sub-committee has been giving thought to measurements of power factor and dielectric constant at short wave lengths, such as from 15 to 30 meters, and several laboratories have been working on the problem. Three independent methods have been developed and are in use, and inter-comparisons with these will be carried on by the sub-committee.

The work of writing a method involving an electrical endurance test at high frequencies is being carried on. Since there are several methods which might be used depending upon the conditions, the aim is to write a method which may be more generally applicable.

Sub-Committee VIII on Resistance and Power Factor Measurements (H. L. Curtis, chairman).—In addition to the work which has led to the recommendations involving the measurements of resistivity so as to include the resistivity of liquids in the Tentative Methods D 257 - 26 T as mentioned earlier in this report, the sub-committee has been actively engaged in obtaining data leading to the development of methods for measuring power factor and dielectric constant of liquids and solids at ordinary frequencies. A set of specimens will be circulated among the different laboratories using different methods so as to get a comparison of results obtained by the various methods. Some of these results have already been obtained, but the work has not been sufficient to draw any conclusions.

This report has been submitted to letter ballot of the committee, which consists of 52 members; 46 returned their ballots, of whom 37 have voted affirmatively, and none negatively.

Respectfully submitted on behalf of the committee,

H. S. VASSAR,
Chairman.

T. S. TAYLOR,
Secretary.

EDITORIAL NOTE

The tentative revisions issued in 1927 and 1928 of the Standard Methods of Testing Molded Insulating Materials were accepted at the annual meeting and subsequently adopted as standard by letter ballot vote of the Society on September 3, 1929. Also, the proposed revision of Sections 7, 10, 22 and 24 of these Standard Methods, recommended for the first time, thus requiring a nine-tenths vote, were accepted by a unanimous vote at the annual meeting and subsequently adopted as standard by letter ballot vote of the Society on September 3, 1929. The methods in their revised form appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 259. On recommendation of the committee the proposed revision of Section 23 of the Standard Methods of Testing Molded Insulating Materials was accepted at the annual meeting for publication as tentative, instead of being immediately adopted as originally recommended, subject to a favorable subsequent letter ballot of the committee. The subsequent letter ballot resulted in 32 affirmative and 1 negative votes with 8 members not voting. The proposed revision appears on p. 880.

The proposed revisions of the Standard Methods of Testing Electrical Insulating Oils were accepted for publication as tentative and appear on page 875.

The proposed revisions of the Tentative Methods of Testing Insulating Varnishes; of Testing Electrical Porcelain; of Testing Cable Splicing and Pothead Compounds; of Testing Untreated Insulating Paper; Test for Surface Resistivity and Volume Resistivity of Solid Insulating Materials, and Methods of Testing Varnished Cloth Tapes were accepted for publication as tentative. The methods as revised appear on pages 728, 738, 751, 758, 773, and 786, respectively.

APPENDIX

TENTATIVE REVISION OF STANDARD METHODS OF TESTING ELECTRICAL INSULATING OILS
(A.S.T.M. DESIGNATION: D 117 - 27)[1]

Scope. 1. These methods are intended for oil used in transformers, oil circuit breakers and similar electrical apparatus as an insulating or cooling medium, or both.

SAMPLING

General. 2. Samples shall be taken and handled in such a manner that the tests made upon them indicate the characteristics of the shipment. Some tests are greatly affected by the most minute traces of impurities. This is particularly the case with the sludge test[2] and the dielectric strength test, the latter being affected by almost infinitesimal traces of moisture. If these tests are to be made, it is important that the samples be handled with the utmost care to prevent such contamination. All tests are usually made on samples taken from drums. In some cases dielectric strength tests are not made on samples taken from tank cars. Samples from tank cars are usually tested only for the physical and chemical properties which are not affected by *slight* amounts of moisture; care, however, shall be exercised not to introduce into such samples extraneous contamination which might affect the sludge test.[2] It is imperative, therefore, that the procedure and precautions for obtaining and transporting samples of the oil to be tested, as specified in Sections 3 to 8, inclusive, shall be observed.

APPARATUS

Thiefs. 3. (*a*) *General.*—Thiefs shall be used for withdrawing samples of oil from drums, tank cars, or other containers in which shipment is made. Glass or metal thiefs may be used.

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[1] Criticisms of this revision are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corp., 230 Grove St., Bloomfield, N. J.

This proposed revision, when adopted, will supersede Sections 1 to 7 of the present Standard Methods of Testing Electrical Insulating Oils (A.S.T.M. Designation: D 117 - 27), 1927 Book of A.S.T.M. Standards, Part II, p. 796.

[2] The great importance of a sludging test is recognized but none is included in this standard at this time because none of the methods in general use is considered sufficiently satisfactory by Committee D-9 to warrant consideration for standardization purposes. Certain new methods are being actively investigated. See reports of Committee D-9 for 1922, 1923, 1924, 1925, 1926, 1927, 1928 and 1929. For such reports see Part I of the *Proceedings* of the American Society for Testing Materials, Vols. 22 to 29, respectively.

(*b*) *For Drums.*—For sampling drums or smaller containers the thiefs shall be of suitable design so as to reach within approximately $\frac{1}{8}$ in. (about 3 mm.) of the bottom and should have a capacity of approximately 1 pt. or 1 qt. (0.5 or 1 liter). For sampling the smaller containers a proportionately smaller similar thief may be used.

NOTE.—A convenient and simple thief for sampling 50-gal. drum containers is shown in Fig. 1, which illustrates a sheet metal thief 36 in. in length, $1\frac{1}{4}$ in. in diameter, with cone-shaped caps over the ends and having openings at the ends $\frac{3}{8}$ in. in diameter. Three legs, equally spaced around the thief at the lower end, long enough to hold the opening $\frac{1}{8}$ in. from the bottom of the container, aid in securing a good representative sample. Two rings soldered to opposite sides of the tube at the upper end will be found convenient for holding the thief by slipping two fingers through them, leaving the thumb free to close the opening.

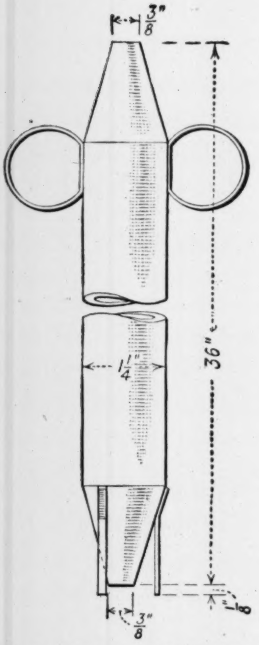

FIG. 1.—Thief for Sampling Drums.

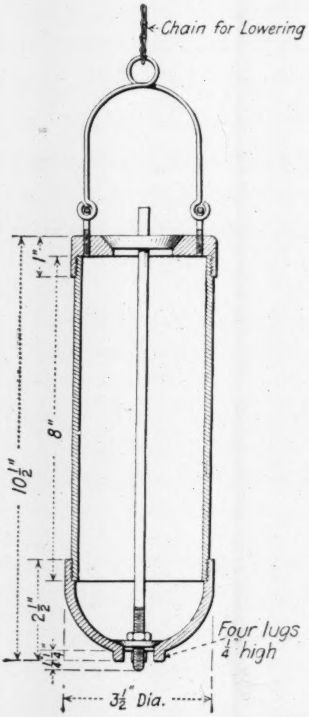

FIG. 2.—Thief for Sampling Tank Cars.

(*c*) *For Tank Cars.*—For sampling tank cars the thief shall be designed so as to make it possible to secure the sample from within at least 0.5 in. of the bottom.

NOTE.—A thief suitable for sampling tank cars may be made from metal tubing and castings, machine-finished all over. A valve rod whose projecting stem strikes the bottom of the car, opens the valve automatically and simultaneously releases the air through the top. Such a thief is illustrated in Fig. 2.

Sample Containers.

4. Tin cans or cork or glass-stoppered clear-glass bottles in cartons may be used as containers for the samples. The containers shall be clean and dry.

NOTE.—The clear-glass bottle offers the advantage that it may be examined to see that it is clean. It also allows visual inspection of the oil before testing, permitting the detection of free water or solid impurities. However, if samples are placed in glass bottles, they shall be kept in the dark until portions are removed for testing for color and sludge forming characteristics, as light produces changes in these properties. For this reason cardboard cartons with covers shall be provided for each bottle into which the bottle with its sample of oil shall be placed immediately after sampling. Rubber stoppers shall never be used. When cork is used it shall be of good quality with a new cork for each sample. Contact of the oil with the cork may be prevented by wrapping some tin or aluminum foil around the cork before forcing it into the mouth of the bottle. If glass-stoppered bottles are used, precaution shall be taken to insure that perfectly fitting stoppers are secured. A tin can fitted with a screw cap protected with a cork disk faced with tin or aluminum will endure harder usage. If tin cans are to be employed, only those having seams soldered on the exterior surfaces shall be used.

Cleaning of Apparatus.

5. (*a*) *General.*—All thiefs and sample containers shall be cleaned thoroughly before using, special care being taken that no lint or other fibrous material remains in or on them. Care shall be taken to insure the complete removal of all traces of soldering flux from new thiefs and new cans.

NOTE 1.—Thiefs and containers which are not chemically clean and dry are likely to contaminate the samples and cause misleading results on some of the tests.

NOTE 2.—To insure the greatest ease in removing traces of soldering flux, a flux of rosin in a suitable solvent is recommended for soldering all seams. Such a flux is easily removed with gasoline, whereas, many other fluxes are very hard to remove. Minute traces of flux may contaminate the sample so that the results obtained on dielectric strength tests and various sludge tests may be erroneous.

(*b*) *Thiefs.*—Thiefs, before using, shall be cleaned by rinsing with oil-free gasoline and dried in the hot cabinet described in Section 6 (*a*). The best procedure is to rinse them after the sampling has been finished and then place them in the hot cabinet, as in this way they will be ready for use without further cleaning when the next shipment is to be sampled.

(*c*) *Sample Containers.*—Sample containers, before using, shall be rinsed with oil-free gasoline and dried. They shall then be washed with strong soapsuds, rinsed thoroughly with distilled water and then dried by passing a current of warm air through the containers, after which they shall be immediately placed in the hot cabinet described in Section 6 (*a*). A similar washing will be sufficient for re-use of the containers which have held new oil, but those which have contained used oil shall be washed with both gasoline and benzol before using soapsuds.

Storage of Apparatus.

6. (*a*) *General.*—When not in use all thiefs and sample containers shall be kept in a hot, dry, dust-free cabinet or compartment at a temperature not less than 38° C. (100° F.).

(*b*) *Thiefs.*—Thiefs shall be kept at all times in a vertical position in the hot cabinet in a rack having a suitable drainage receptacle at the base.

(*c*) *Sample Containers.*—Containers for samples, after washing and drying as described in Section 5 (*c*), shall be kept unstoppered while in the hot cabinet but shall be closed immediately on removal. In cases where it is necessary to prepare, in advance, containers which cannot be kept in the hot cabinet until approximately such time as the sample is placed therein (as for example, when bottle containers are prepared to be sent to a distant sampling point) the same procedure of washing and drying shall be followed as described in Section 5 (*c*). In these cases, after the bottles are corked or stoppered and removed from the hot cabinet, the corks or stoppers shall be capped with paper which is tied securely on the neck, and then the capped corks or stoppers shall be sealed by dipping into melted paraffin wax so as to cover all of the paper cap and part of the neck. If this procedure is followed, care shall be taken in removing the paraffined caps preparatory to filling the bottles with samples, that no paraffin contaminates the sample.

PROCEDURE

Procedure for Sampling New Oils.

7. (*a*) *General.*—A sufficient number of samples shall be taken to cover the requirements of the tests. It is recommended that 1 qt. of oil be taken as a sample if complete physical and chemical tests are to be made and at least 1 pt. if only the dielectric strength tests are to be made.

(*b*) Drums, tank cars, or other containers of oil shall not be sampled until the oil is at least as warm as the surrounding air, because cold oil may condense enough moisture from a humid atmosphere to affect seriously its insulating properties. Samples shall, of course, never be taken in the rain and precautions shall be taken during sampling to prevent contamination such as that which may occur from wind-blown dust or other sources.

(*c*) Samples of oil from drums and cans shall be taken only after the oil has remained undisturbed for at least eight hours.

(*d*) Drums and barrels of oil to be sampled shall be lined up, preferably on their sides with their bungs up. The bungs shall be unsealed, removed, and laid with the oily sides up beside the bung holes. The top hole of the thief shall be closed with the thumb and the thief thrust about 1 ft. (30 cm.) into the oil. The thumb shall then be removed, allowing the oil to flow into the thief. The upper end of the thief shall again be closed with the thumb and the thief withdrawn. The oil remaining in the thief shall be used for rinsing out the thief by holding the thief nearly horizontal and turning so that the oil comes in contact with that part of the inside surface of the thief which is immersed when taking the final sample. During this rinsing of the thief, care shall be taken to avoid handling any portion of the thief which is subsequently immersed in the oil to be sampled as moisture from the fingers or hands may be sufficient to cause enough contamination of the oil to secure a low value in dielectric strength test. The oil used for rinsing shall be thrown away and the thief allowed to drain. The thief shall again be inserted into the oil but this time the thumb is not removed until the thief reaches the bottom of the container. When the thief is filled, the thumb shall be replaced, the thief quickly withdrawn and the contents allowed to flow into the sample container. The bottom hole shall not be closed with the fingers of the other hand. The free hand shall be used to guide the stream of oil by touching the thief only as necessary. The oil shall not be allowed to flow over the hand or fingers before it flows into the sample container nor shall any excess be allowed to flow over the drum or barrel and back again through the open bung hole. When the sample container is filled it shall be closed quickly and the bung replaced in the drum and tightened. The sample container shall be labeled at once and taken to the testing laboratory as quickly as feasible.

(*e*) Smaller containers, such as cans, shall be sampled with the drum thief or a proportionately smaller similar thief using a method similar in general to the one described for drums and barrels in Paragraph (*d*).

(*f*) Tank cars of oil shall be sampled by introducing the tank-car thief through the manhole on top of the car, the cover of which shall be removed carefully so as not to introduce any dirt into the oil. The thief shall be lowered until it strikes the bottom of the tank car when it automatically opens and fills. Under no conditions shall samples be taken from the bottom draw-off.

(*g*) When separate samples are being taken from a consignment or part of a consignment, care shall be exercised to prevent contaminating the samples. A separate thief shall be used for each sample or the thief previously used shall be well drained and then thoroughly washed with oil from the next container to be sampled, throwing away the oil thus used for washing, before taking the portion reserved for the sample (see Section 7(*d*)). Enough thiefs shall be provided to insure thorough drainage of each thief after rinsing with oil to be sampled before using it to withdraw the sample. For obtaining only a few samples, two thiefs are sufficient, but for obtaining a large number of samples (for example, sampling a carload of drummed oil) six or more are desirable.

(*h*) When one average sample of a consigmnent or batch is being taken, the same thief may be used throughout the sampling operation, omitting the precaution of rinsing the thief with oil before taking any of the portions that go to make up the total average sample.

Procedure for Sampling Oil in Service.

8. When taking samples of oil from transformers, oil circuit breakers and similar electrical apparatus where a thief cannot be used, the precautions outlined in the preceding sections shall be observed so far as practicable. In addition, care shall be taken to procure a sample which fairly represents the oil at the bottom of the tank. Transformer and oil circuit-breaker tanks, and similar electrical apparatus are usually provided with drain pipes or sampling cocks from which the sample may be allowed to flow into the sample container. Sufficient oil shall first be allowed to flow to waste through these drain pipes or sampling cocks before the sample is taken, in order to insure that the sample will not be that portion which was stored in the drain pipe. For this reason, the valve and the drain pipe should be sufficiently small to be emptied with convenience and yet sufficiently large to give an even flow of oil and avoid clogging by sediment. A U. S. Standard $\frac{1}{4}$-in. nominal size pipe (equivalent to an inside diameter of approximately 9 mm.) with suitable valve is recommended. This, of course, may be separate from the drainage pipe and valve or may be connected to the drainage valve by means of a suitable reducer.

REPORT OF COMMITTEE D-11
ON
RUBBER PRODUCTS

Committee D-11 on Rubber Products has held one meeting during the past year, at Chicago on March 22, 1929, during the spring Group Meeting of the Society. It was decided by the Advisory Sub-Committee when it met in New York on November 9, 1928, to omit the usual fall meeting, as the work of the committee was progressing satisfactorily.

There have been several changes in the personnel of the committee during the year. Mr. R. A. Schatzel, Director of Research, General Cable Corporation, Rome Wire Co., Rome, N. Y., has been elected to membership and is serving on Sub-Committee V on Insulated Wire and Cable. Mr. A. W. Suberra has resigned and Mr. H. S. White has been appointed in his place. Messrs. R. E. Newcomb and F. E. Harris have resigned. Mr. W. L. Sturtevant has been appointed chairman of Sub-Committee VI on Packings, Gaskets and Pump Valves, replacing Mr. H. J. Force. Mr. W. A. Gibbons was appointed chairman of Sub-Committee X on Standard Procedure for Testing Rubber Products to succeed Mr. J. E. Partenheimer, resigned. Mr. H. E. Morse was appointed chairman of Sub-Committee I on Mechanical Rubber Hose to succeed Mr. N. G. Bruce, deceased.

Committee D-11 wishes to record its sorrow in the loss by death of Mr. N. G. Bruce, who served as chairman of Sub-Committee I on Mechanical Rubber Hose and who had shown for many years his active interest in the work of the committee by giving unsparingly of his time to the activities of the Society. Mr. Bruce was an outstanding figure in the rubber industry and his loss will be keenly felt by the committee.

RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS

I. *Proposed Tentative Standard.*—The committee recommends that the Proposed Tentative Method of Test for Hardness of Soft Rubber (in Slab Form), as appended hereto,[1] be accepted for publication as tentative.

II. *Proposed Revision of Tentative Standard.*—The committee recommends that the Tentative Methods of Chemical Analysis of

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[1] See p. 819.

Rubber Products (D 297 – 28 T)[1] be revised as follows and continued as tentative:

Section 15 (a).—Change the third sentence of this paragraph from its present form: namely,

> The percentage of free sulfur is determined and deducted from the total extract.

to read as follows:

> The percentage of free sulfur and the percentage of waxy hydrocarbons are determined and their sum deducted from the total extract.

Add the following sentence at the end of Paragraph (*b*):

> The chloroform extract may also include other materials.

Section 31.—Change the second sentence to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

> Filter into a 250-cc. beaker, wash with two *25-cc.* portions of [25-cc. of] boiling alcohol; then with three 25-cc. portions of boiling water, and evaporate the filtrate *just* to dryness.

The committee recommends that the Society's eight standards and remaining four tentative standards under the jurisdiction of Committee D-11 be continued in their present status.

The Tentative Specifications for Steam Hose (D 54 – 24 T) have been tentative for more than three years. The committee has considered action on these specifications but wishes to recommend that they be continued as tentative because of pending revisions in the American Railway Association specifications for steam hose with which these specifications should conform.

The committee has received from the National Electric Light Association a request to cooperate with them in the preparation of new purchase specifications for rubber gloves of higher quality than those now covered by the A.S.T.M. Standard Specifications for Rubber Gloves for Electrical Workers on Apparatus or Circuits not Exceeding 3000 Volts to Ground (D 120 – 23). These gloves are to be used on circuits having voltages up to 8000 volts to ground. Committee D-11 has voted to authorize Sub-Committee IV on Protection of Persons from Electric Shock, to proceed with such work as may be necessary to prepare specifications for rubber gloves for voltages not exceeding 8000 volts to ground.

At the 1928 annual meeting, the Sectional Committee on Specifications for Rubber-Lined Fire Hose submitted proposed tentative specifications which were accepted as tentative subject to the deletion of two notes. This reservation was referred to the other sponsor, namely, the Fire Protection Group, which expressed willingness to see the specifications approved without these two notes but reserving the right to include these notes in any specifications which might be issued by various units of the group. In consequence, the Tentative Specifications for Cotton Rubber-Lined Fire Hose for Public and Private Fire Department Use (A.S.T.M. Designation: D 296 - 28 T) as accepted by the Society at the 1928 annual meeting were approved on January 21, 1929, as American Tentative Standard by the American Standards Association.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1072 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 730.

ACTIVITIES OF SUB-COMMITTEES

Substantial progress has been made during the year in the work of the various sub-committees, even though all the results of the work are not yet ready to be presented in the form of new tentative standards or revisions of existing standards.

Sub-Committee I on Mechanical Rubber Hose (H. E. Morse, chairman.)—In connection with the work of this sub-committee, a program on investigation and standardization of test methods for steam hose has been authorized. It is the intention to consider new tests which will provide better measures of service performance as well as to standardize the conditions and methods of present tests. One suggestion involves the development of a flexing test under steaming conditions. It is the opinion of the committee that work of this sort will render very valuable service to both consumers and producers.

Sub-Committee II on Belting (E. H. Grafton, chairman).—Since the withdrawal of the Standard Specifications for Rubber Belting for Power Transmission (D 53 - 24) at the 1928 annual meeting, the work of this sub-committee has centered in the two sections which were appointed, first, for the preparation of standard methods for testing power transmission belting, and second, for the classification of various types of transmission belting. These sections are not yet ready to report.

Sub-Committee V on Insulated Wire and Cable (C. B. Martin, chairman).—The Tentative Specifications for Insulated Wire and Cable: 30-per-cent Hevea Rubber (D 27 - 28 T) are being continued as tentative and the committee would appreciate discussion and suggestions. Mention has been made that the specifications required that joints in the insulation in cables must not be more than 10 per cent less than the specified section, but in no case to exceed 0.031 in., whereas, in all cases, the joints should be over and not under in size.

The chairman of this sub-committee was charged with the formation of a section on ignition service, but investigation among the automotive companies has failed to elicit much interest and the advisability of rubber for this service has been questioned. It would appear that this work should accordingly not be undertaken. Work is in progress in this sub-committee on a performance specification for rubber insulation.

Sub-Committee IX on Insulating Tape (J. M. Bierer, chairman).—The tape tester, illustrated in the Standard Specifications for Friction Tape for General Use for Electrical Purposes (D 69 - 28) and in the Tentative Specifications for Rubber Insulating Tape (D 119 - 28 T), has been the subject of considerable interest and the committee has received numerous requests for detailed drawings of this equipment. The Tentative Specifications D 119 - 28 T are being continued as tentative. These specifications have been the subject of some interchange of comment and are being considered for advancement to standard. There is still a question, however, in regard to the requirement in the chemical analysis which specifies 8 hours heating at 212° F. for the acetone extraction for determining free carbon. The sub-committee is considering a modification of this requirement.

Sub-Committee X on Standard Procedure for Testing Rubber Products (W. A. Gibbons, chairman).—The question of a revision of the present standard methods for physical testing as given in the Standard Methods of Testing Rubber Products (D 15 - 24) is being considered by this sub-committee. This work will be carried on in cooperation with a similar Committee, of the American Chemical Society, on Methods for Physical Testing of Rubber Products.

Sub-Committee XI on Chemical Analysis of Rubber Products (S. Collier, chairman).—This sub-committee is recommending revisions, as mentioned earlier in the report, in the Tentative Methods of Chemical Analysis of Rubber Products (D 297 - 28 T).

Sub-Committee XIV on Abrasion Tests for Rubber Products (H. A. Depew, chairman).—This sub-committee has considered the results of a series of laboratory tests and service tests. These tests were carried out on each of five compounds which were cured in three laboratories and tested after exposure to wet and dry atmospheres. The laboratory tests which were completed over a year ago showed considerable variation, depending on which laboratory cured the stock, which laboratory tested it and the moisture conditions. The service tests have recently been completed and showed no better check results than the laboratory tests. In general, the results were disappointing. The sub-committee feels that abrasion testing has advanced decidedly during the last few years but the fact that it is a relative test only is a serious handicap. The sub-committee has decided to see what can be done to further the development of a satisfactory abrasion test by investigating various factors which are involved in abrasive wear. Accordingly, the sub-committee plans to undertake the study of known tear tests and the possible development of a new tear test.

Sub-Committee XV on Life Tests for Rubber Products (Stanley Krall, chairman).—This sub-committee has considered results which have been completed to date in an extensive series of aging tests. The entire series has not yet been completed but the results to date show considerable variation by the different laboratories. The function of this work is not to correlate an accelerated aging period with a definite period of natural life, as the sub-committee believes that no such definite conclusion can be drawn but rather it is the purpose to arrive at standard conditions for aging tests. The sub-committee is endeavoring to ascertain the reasons for the rather wide variations in the results.

Sub-Committee XVII on Rubber Products for Absorbing Vibration (L. C. Conradi, chairman).—The section on hardness testing of this sub-committee has been actively engaged in studying two hardness testing instruments which were submitted to the committee a year ago. A series of tests has been made on these instruments which resulted in the sub-committee making definite recommendations to the instrument makers for changes in the instruments. These changes have been made and the instruments again submitted to further test. The results of this work have been submitted in the form of a recommendation for the adoption as tentative of a new Method of Test for Hardness of Soft Rubber (in Slab Form), appended hereto.[1]

The recommendations appearing in this report have been submitted to letter ballot of the committee with the following results:

Item	Affirmative	Negative	Not Voting
I. NEW TENTATIVE STANDARD			
Tentative Method of Test for Hardness of Soft Rubber (in Slab Form)	26	0	11
II. PROPOSED REVISION OF TENTATIVE STANDARD			
Tentative Methods of Chemical Analysis of Rubber Products (D 297 - 28 T)	33	0	6

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[1] See p. 819.

This report has been submitted to letter ballot of the committee, which consists of 62 members; 44 members returned their ballots all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

L. C. CONRADI,
Chairman.

A. W. CARPENTER,
Secretary.

EDITORIAL NOTE

The proposed Tentative Method of Test for Hardness of Soft Rubber (in Slab Form) was accepted for publication as tentative and appears on page 819.

The proposed revision of the Tentative Methods of Chemical Analysis of Rubber Products was accepted. The tentative methods in their revised form appear on page 795.

REPORT OF COMMITTEE D-13
ON
TEXTILE MATERIALS

Committee D-13 on Textile Materials held two meetings during the past year, one in Washington, D. C., on October 18 and 19, 1928, and one in Boston and Lowell, Massachusetts, on March 14 and 15, 1929. A third meeting will be held in conjunction with the annual meeting of the Society in June. The meetings were very satisfactory both from the standpoint of attendance and work accomplished. A number of interesting technical papers were presented at each session which added considerably to the value of the meetings.

At the October meeting James E. Skane was elected secretary to fill the vacancy created by the resignation of Douglas G. Woolf.

The present membership of the committee consists of 152 members, of whom 57 are classed as producers, 49 as consumers, and 46 as general interests.

Committee D-13 covering, as it does, the entire textile field naturally includes many interests which have little in common. Its sub-committees were formed as need arose and without much correlation. Uncertainty as to which group should attack a problem or duplication of effort has resulted. It is felt that more and better work can be done if those sub-committees interested along similar lines were more closely associated. A plan for this reorganization has been submitted to the committee and was definitely approved at the March meeting. A special committee is now working out the details. In brief, this plan would place all present sub-committees primarily interested in a given fiber as sections of a new sub-committee on the fiber in question. Thus, the present Sub-committees on Tire Fabrics; on Cotton Yarn and Thread; on Hose, Belt and Numbered Duck; on Osnaburg Cement Bags; on Narrow Fabrics; on Light and Medium Cotton Fabrics; and on Raw Cotton would become sections of a Sub-Committee on Cotton. Other groups would be treated similarly. It is expected that the reorganization will be effected in time for publication in the 1929 A.S.T.M. Year Book.

RECOMMENDATIONS AFFECTING STANDARDS AND TENTATIVE STANDARDS

The recommendations of the committee affecting the standards and tentative standards under its jurisdiction are summarized below together with the analysis of the letter ballot on each item. Comments, where necessary, are made under Sub-Committee Activities.

I. Proposed Tentative Standards.—The committee recommends that the following proposed new tentative standards be accepted for publication as tentative as appended hereto:[1]

1. Proposed Tentative Specifications for Asbestos Tape for Electrical Purposes.
2. Proposed Tentative Specifications for Chafer Tire Fabrics.

II. *Proposed Revisions of Tentative Standards.*—The committee recommends that the Tentative Methods for Identification of Textile Fibers and their Quantitative Determination in Mixed Goods (D 276 - 27 T),[2] be revised as indicated in the Appendix to this report, the methods as thus revised being continued as tentative.

III. *Advancement of Tentative Standards to Standard.*—The committee recommends the advancement of the following tentative standards to standard without revision:

1. Tentative Specifications for Tolerances and Test Methods for Certain Light and Medium Cotton Fabrics (D 274 - 27 T).[3]
2. Tentative Specifications and Tolerances for 23/5/3 Carded American Tire Cord (D 298 - 28 T).[4]
3. Tentative Specifications for Tolerances and Test Methods for Asbestos Yarns (D 299 - 28 T).[4]

IV. *Tentative Standards Continued as Tentative.*—The committee recommends that the following tentative standards be continued as tentative for another year without revision:

1. Tentative Methods of Testing Cotton Fibers (D 152 - 22 T) as recommended by Sub-Committee XXI.
2. Tentative Methods for Testing Grease Wool and Allied Fibers for Scoured Content (D 232 - 25 T) as recommended by Sub-Committee XII.
3. Tentative Specifications for Tolerances and Test Methods for Rayon (D 258 - 27 T).
4. Tentative Specifications and Tests for Cuban (Jute) Raw Sugar Bags (D 275 - 27 T).
5. Tentative Specifications for Tolerances and Test Methods for Knit Goods (D 231 - 28 T).

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[1] See pp. 821 and 825, respectively.—ED.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 1044 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 781.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 1039 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 768.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, pp. 1103, 1096 (1928); also 1928 Book of A.S.T.M. Tentative Standards, pp. 770, 761.

6. Tentative Definitions of Terms Relating to Textile Materials (D 123 – 28 T).

The above recommendations have been submitted to letter ballot, the results which are set forth in the following table.

Items	Affirmative	Negative	Not Voting
I. PROPOSED TENTATIVE STANDARDS			
Proposed Tentative Specifications for Asbestos Tape for Electrical Purposes	20	1	27
Proposed Tentative Specifications for Chafer Tire Fabrics	23	1	25
II. PROPOSED REVISION OF TENTATIVE STANDARD			
Tentative Methods for Identification of Textile Fibers and Their Quantitative Determination in Mixed Goods (D 276 – 27 T)	52	0	11
III. ADVANCEMENT OF TENTATIVE STANDARDS TO STANDARD			
Tentative Specifications for Tolerances and Test Methods for Certain Light and Medium Cotton Fabrics (D 274 – 27 T)	33	0	15
Tentative Specifications and Tolerances for 23/5/3 Carded American Tire Cord (D 298 – 28 T)	25	0	23
Tentative Specifications for Tolerances and Test Methods for Asbestos Yarns (D 299 – 28 T)	22	0	26

SUB-COMMITTEE ACTIVITIES

Below are set forth some of the activities of the various sub-committees giving details, where necessary, on the above recommendations.

Sub-Committee II on Fabric Test Methods (W. E. Emley, chairman).—This sub-committee is continuing its work on methods of measuring thickness of napped and pile fabrics. Studies of methods of analysis of cotton-wool mixtures, of detection of rayon, and of measuring tensile strength of cordage (not over $\frac{1}{4}$ in.), twines and threads are in progress.

Sub-Committee IV on Identification of Textile Fibers (E. H. Davis, chairman).—This sub-committee recommends that the Tentative Methods for Identification of Textile Fibers and Their Quantitative Determination in Mixed Goods (D 276 – 27 T)[1] be revised as indicated in the Appendix to this report and continued as tentative in their proposed revised form. The sub-committee believes that these revisions enlarge and improve the methods in such a way as to warrant advancement to standard in the near future.

Sub-Committee V on Nomenclature and Definitions (F. R. McGowan, chairman).—This sub-committee is reviewing the definitions for which Committee D-13 is responsible and will undoubtedly have definite recommendation ready for submission next year. It is accordingly recommended that the Tentative Definitions of Terms Relating to Textile Materials (D 123 - 28 T) be continued as tentative.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 1044 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 781.

Sub-Committee VI on Tire Fabrics (B. H. Foster, chairman).—This sub-committee is submitting proposed Specifications for Chafer Tire Fabrics, as appended hereto,[1] which meet a demand for such specifications on these fabrics. Breaker fabrics will be studied probably during the coming year.

Sub-Committee VII on Cotton Yarn and Threads (K. B. Cook, chairman).—This sub-committee is undertaking the study of the effect of temperature and humidity on strength and stretch of tire cords. This work should be productive of valuable information on this important material.

Sub-Committee VIII on Humidity (G. B. Haven, chairman).—This sub-committee is engaged in framing a series of correction curves for the effect of temperature and humidity on cotton fabrics of all weights. Other fibers, such as rayon and wool, are being investigated. Some results should be available during the coming year.

Sub-Committee IX on Hose, Belt and Numbered Duck (B. L. Whittier, chairman).—This sub-committee is undertaking a study of proper method of testing hose and belt ducks for tensile strength. It is also considering the question of specifications for standard weights of these ducks.

Sub-Committee XI on Knit Goods (R. H. Emmott, chairman).—This sub-committee is carrying on additional studies bearing on the test methods for knit goods. It is planning work on specifications for certain mechanical knit fabrics.

Sub-Committee XII on Raw Wool (G. W. Fiss, Jr., chairman).—Owing to the necessity of further work by this sub-committee to check the figures for moisture regain, it is deemed advisable that the Tentative Methods for Testing Grease Wool and Allied Fibers for Scoured Content (D 232 - 25 T) be continued as tentative for another year without revision.

Sub-Committee XV on Rayon (A. M. Tenney, chairman).—It has been found that there are certain changes in the characteristics of rayon which might result in making the previously determined regain (14½ per cent) in rayon inaccurate. The sub-committee is at present engaged in checking this matter.

Sub-Committee XVI on Asbestos Textiles (J. M. Weaver, chairman).—This sub-committee is submitting its first proposed specification on asbestos fabrics, proposed Tentative Specifications for Asbestos

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[1] See p. 825.—ED.

Tapes for Electrical Purposes as appended hereto,[1] having paved the way with the Tentative Specifications for Asbestos Yarn (D 299 - 28 T)[2] which are being recommended for advancement to standard. The original request for such specifications came from one of the large consumers of insulating materials for electrical purposes.

Sub-Committee XVII on Light and Medium Cotton Fabrics (R. T. Fisher, chairman).—This sub-committee is engaged in drawing up specifications for a sheeting suitable for the manufacture of insulating tape.

Sub-Committee XXI on Raw Cotton (H. W. Barre, chairman).—This sub-committee was organized in the fall of 1927 and given jurisdiction over the Methods of Testing Cotton Fibers which have been tentative since 1922. It is engaged in compiling data which will undoubtedly lead to a revision of the methods, hence it is recommended that the Tentative Methods of Testing Cotton Fibers (D 152 - 22 T) be continued as tentative for another year without revision.

Sub-Committee XXII on Textile Finishes and Finishing Materials (O. R. Flynn, chairman).—This sub-committee was organized just prior to the March, 1929, meeting at which time it held its first session. It has a number of interesting problems before it. Preliminary steps have been taken to carry on some work in conjunction with certain sub-committees of the American Association of Textile Chemists and Colorists.

A special election of officers was held June 25, 1929. This was made necessary by the resignation of David C. Scott as second vice-chairman and the change of employment of the chairman. W. H. Whitcomb was re-elected chairman and Warren E. Emley was elected second vice-chairman.

This report has been submitted to letter ballot of the committee, which consists of 152 members, 54 members returned their ballots, of whom 52 have voted affirmatively and 2 negatively.

Respectfully submitted on behalf of the committee,

W. H. WHITCOMB,
Chairman.

J. E. SKANE,
Secretary.

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[1] See p. 821.—ED.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1096 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 761.

EDITORIAL NOTE

The proposed Tentative Specifications for Asbestos Tape for Electrical Purposes, and for Chafer Tire Fabrics were accepted for publication as tentative and appear on pages 821 and 825, respectively.

The proposed revision of the Tentative Methods for Identification of Textile Fibers and Their Quantitative Determination in Mixed Goods was accepted. The tentative methods in their revised form appear on page 827.

The Tentative Specifications for Tolerances and Test Methods for Certain Light and Medium Cotton Fabrics; Specifications and Tolerances for 23/5/3 Carded American Tire Cord, and for Tolerances and Test Methods for Asbestos Yarns were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, pages 162, 164 and 166, respectively.

APPENDIX

PROPOSED REVISIONS OF TENTATIVE METHODS FOR IDENTIFICATION OF TEXTILE FIBERS AND THEIR QUANTITATIVE DETERMINATION IN MIXED GOODS (D 276 - 27 T)[1]

Under "General Characteristics and Appearance of the Most Important Textile Fibers" make the following revisions:

Cotton.—Insert the following additional paragraph as the first paragraph:

Cotton, including several different kinds, consists of seed hairs obtained from different species of plants of the genus *Gossypium.* The kinds most used are American Upland cotton from *Gossypium hirsutum,* Sea Island from *Gossypium barbadense,* Egyptian supposed to be from a hybrid derived in part from *Gossypium barbadense,* India cotton from *Gossypium herbaceum* and Chinese cotton from *Gossypium nanking.*

Flax or Linen.—Change from its present form: namely,

Flax or Linen:

Flax fibers appear as long, pointed, cylindrical cells, colorless, and fairly uniform in structure. They usually possess a central lumen as a narrow line, which often appears to be double. Characteristic slight swellings or nodes are to be found at fairly regular intervals, with fine, almost invisible cross-lines. The nodes, discolorations, and cross-lines are more pronounced in woven fabrics than in raw flax.

Individual fibers have very variable diameters, the finest flax being finer than cotton. The fibers may be split into finer and finer sizes almost indefinitely.

Commercial flax usually runs about 20 in. in length, but individual fibers may run up to 36 in. or even longer. In woven fabrics, the yarns at times will show a characteristic abrupt change in diameter locally where fibers have been partly split off in hackling. In contrast to this. cotton yarns vary in size in a tapering manner.

to read as follows:

Flax or Linen:

Flax fibers are bast fibers from the inner bark of the flax plant, *Linum usitatisaimum.*

Flax fibers consist of groups of cells, and these ultimate cells are long pointed, colorless and fairly uniform in structure. The central lumen often indistinct and sometimes appearing double, is narrow compared with the thickness of the cell wall.

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[1] *Proceedings,* Am. Soc. Testing Mats., Vol. 27, Part I, p. 1044; also 1928 Book of A.S.T.M. Tentative Standards, p. 781.

Characteristic slight swellings or nodes are to be found at fairly regular intervals, with fine almost invisible cross-lines. The nodes, discolorations and cross-lines are more pronounced in woven fabrics than in raw flax, and recent studies indicate that the cross-lines which have been regarded as especially characteristic of flax, seem to be produced chiefly by the methods of extracting and cleaning the fiber.

Individual flax fibers vary in diameter, from coarse or fine stemmed plants and also depending on how much it has been combed or split up.

Commercial flax usually runs about 20 in. in length, but some fibers may run up to 36 in. or even longer. The ultimate cells of flax range from 15 to 50 mm. (0.6 to 2.0 in.) but in actual practice the fibers are rarely, if ever, reduced to their ultimate cells. In woven fabrics, linen yarns often show a characteristic abrupt change in diameter due to fibers being partly split off in hackling. In contrast to this, cotton yarns vary in size in a tapering manner.

Hemp (Common hemp, *Cannabis sativa*).—Change from its present form: namely,

Hemp (Common hemp, *Cannabis sativa*):

Hemp fibers are composed of groups of long, blunt cells, not pointed at the ends as flax, though often of a forked shape. All show large, well defined lumens, equalling or exceeding the thickness of the walls. There are usually pronounced longitudinal striations, and cross lines are prominent, as are dislocations or folds, swellings and cross fissures. The fiber cross-sections are irregularly oval; the lumen flattened and irregular.

The commercial fibers are usually 1 to 2 yd. in length and in some kinds may be even longer.

There are numerous other fibers classed as hemp; such as, Sunn hemp, Manila hemp, Mauritius hemp, New Zealand hemp, etc., but which differ botanically from common hemp in various ways.

to read as follows:

Hemp (Common hemp, *Cannabis sativa*):

Hemp fibers are bast fibers from the inner bark of the hemp plant, *Cannabis sativa*.

Hemp fibers are composed of groups of long, blunt cells, not pointed at the ends as flax, though often of a forked shape. They all show large, well-defined lumens equal to or exceeding the thickness of the walls. There are usually pronounced longitudinal striations, and cross-lines are prominent, as are dislocations or folds, swellings and cross-fissures. The cell cross-sections are irregularly oval; the lumen flattened and irregular.

The commercial fibers are usually 3 to 8 ft. in length and in some kinds may be even longer. Dew-retted hemp is gray; water-retted hemp is light yellow; and steam or peeled and scraped hemp is semi-translucent.

There are several fibers miscalled hemp, but all are distinctly different from true hemp, and also different from each other. The following list indicates some of these fibers which are actually used in commerce:

Soft Fibers..........	Sunn Ambari Roselle

Hard Fibers..........	Abaca (Manila Hemp) Henequen Sisal Cantala Pitera Mescal Jaumave Tula Palma

Jute.—Insert the following additional paragraph as the first paragraph:

Jute fibers are bast fibers from the inner bark of two closely related plants, India jute, *Corchorus capsularis*, and Desi jute, *Corchorus olitorius*.

Ramie (*Rhea*).—Insert the following additional paragraph as the first paragraph:

Ramie fibers are bast fibers from the inner bark of the ramie or rhea plant, *Boehmeria nivea*.

Under "Quantitative Separation of the Most Common Textile Fibers," and following the material now under the heading "Selective Dyeing Tests for Qualitative Identification" insert the following:

BURNING TEST FOR QUALITATIVE IDENTIFICATION OF VEGETABLE AND ANIMAL FIBERS

Burning Test.—The burning test may be employed as a quick means of distinguishing between vegetable and animal fibers. The vegetable fibers when ignited by a flame burn quickly and completely with the well-known odor of vegetable material; while animal fibers such as wool and silk burn more slowly with a distinct odor similar to burning glue and leave a globule of ashy matter. Silk yarn, which has been weighted with mineral salts, when ignited will not be entirely consumed and there will remain a fine mineral filament.

In the Procedure under "Cotton and Wool Mixtures" change the last two sentences of Method *B* to read as follows by the addition of the italicized words:

Work the sample in this mixture for about 15 minutes, removing it from time to time to another beaker and washing it with a stream of water *into a strainer* to remove the slimy product formed by the action of H_2SO_4 on the cotton. Finally, filter the residue into a weighed Gooch crucible, wash with water until entirely free from acid, *as may be detected by litmus paper*, dry in the oven at 100° C. and weigh the residue which in this case is wool.

REPORT OF COMMITTEE D-14

ON

SCREEN WIRE CLOTH

Since Committee D-14 last reported to the Society in 1927 two meetings have been held, both in connection with the annual meetings in Atlantic City.

The committee's activities still remain more or less dormant awaiting the results of the exposure tests of non-ferrous screen wire cloth, which are taking place at Pittsburgh, Pa., Washington, D. C., Portsmouth, Va., and the Panama Canal. Periodic reports from inspections made by members of the committee at the four locations do not show any indications of failures. The inspections show that all the screens are in good condition at this time, and no comparative data on the various materials under test can be expected for several years. The same is true for the periodic tension tests on samples removed from screen wire cloth exposed at Washington, D.C. After several years' exposure only slight variations have been noted in the tensile properties of the cloth.

The committee has continued to secure through the generous cooperation of the Weather Bureau, the U. S. Bureau of Mines, the Panama Canal Authorities, and the U. S. Navy Department, a comprehensive series of data showing daily variations in atmospheric SO_2 content. It is anticipated that these data will be of considerable assistance in interpreting the results of the exposure tests, and the committee should be glad to place these same data at the disposal of other committees of the Society who might be able to make use of them.

The committee recommends that the Tentative Specifications for Non-Ferrous Insect Screen Cloth (B 50 - 27 T)[1] be advanced to standard. Since the last revision in 1927 no adverse criticism of the specifications has been received.

The following is the result of the letter ballot of the committee on the recommendation made in this report:

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 737 (1928); also 1928 Book of A.S.T.M. Tentative Standards, p. 163.

Item	Affirmative	Negative	Not Voting
TENTATIVE STANDARD ADVANCED TO STANDARD			
Tentative Specifications for Non-Ferrous Insect Screen Cloth (B 50 - 27 T)............	12	0	1

This report has been submitted to letter ballot of the committee, which consists of 17 members; 13 members returned their ballots, of whom 12 have voted affirmatively and 1 negatively.

Respectfully submitted on behalf of the committee,

R. W. WOODWARD,
Chairman

W. H. BASSETT,
Secretary.

EDITORIAL NOTE

The Tentative Specifications for Non-Ferrous Insect Screen Cloth were approved at the annual meeting and subsequently adopted as standard by letter ballot of the Society on September 3, 1929, and appear in the 1929 Supplement to Book of A.S.T.M. Standards, page 95.

REPORT OF COMMITTEE D-16

ON

SLATE

During the past year, Committee D-16 has made considerable progress toward securing data regarding the characteristics and utilization of slate.

At the last meeting of Committee D-16 a new Sub-Committee IX on Utilization and Performance was organized at the suggestion of the consumer interests. It comprises all members of the main committee and is sectionalized for the purpose of coordinating consideration of production, research and practical problems in connection with various methods of laying roofing slate, the care and cleaning of blackboards, etc. In these and related matters, investigations are now under way and architects, educational authorities and others including manufacturers of nails, crayons, cleaning compounds, etc., are collaborating with various members of the sub-committee charged with specialized features of this work.

The outstanding feature of the past year has been the additional interest manifested in the committee's work by the producers in the various slate districts of the country and the greatly increased membership among the producer element resulting therefrom. This may be attributed almost solely to an innovation, which may have general application. Through cooperation with the National Slate Association and Committee D-16, arrangements were made so that all technical matters to be presented at the Annual Convention of the National Slate Association, held in New York City last January, were concentrated in one open session which was held simultaneously with the meeting of Committee D-16 with the chairman of the committee acting as the chairman of the meeting. Members of the Hosts Club of the N.S.A., which group comprises the manufacturers of equipment and supplies used in the quarrying, milling and installation of slate, were also present at this joint session. Special presentations and papers were prepared for the session by the chairmen of the subcommittees of Committee D-16 and others were arranged for by the National Slate Association. Problems relating to improvements in quarrying, milling, finishing and utilizing were outlined and discussed.

An outcome, in addition to establishing a community of interests and understanding, was the immediate and subsequent increase in the membership so that now this committee is able to report ten producer members instead of two and many valuable contributions to its work in the form of suggestions, advice and new procedure.

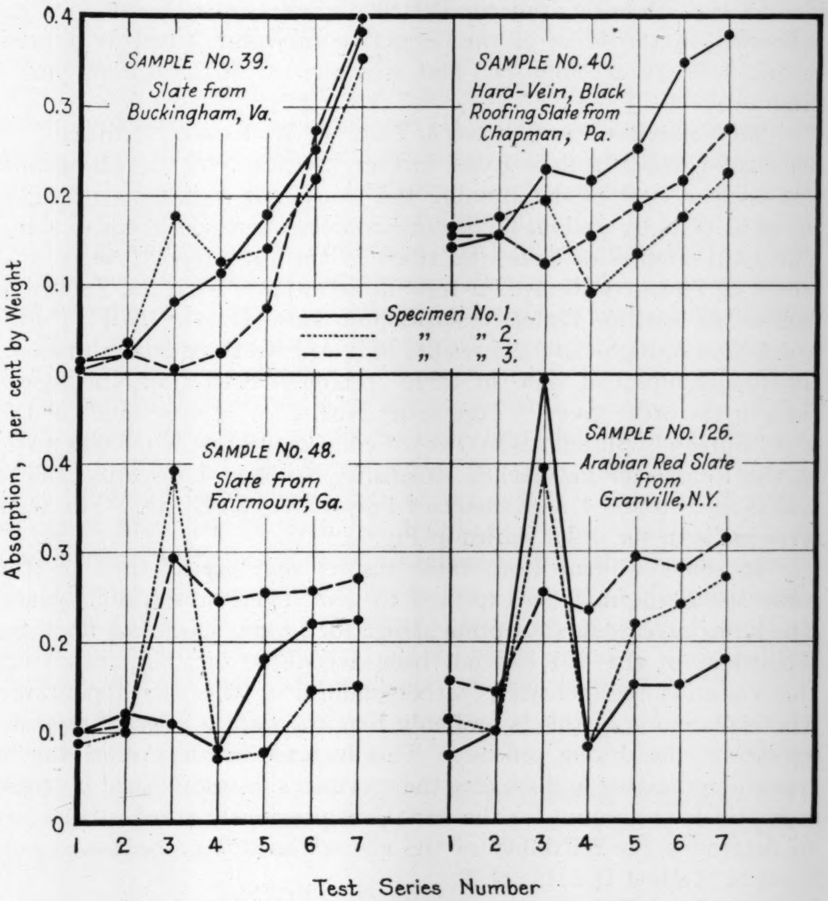

FIG. 1.—Results of Repeated Absorption Tests on Slate.

Instead, therefore, of proposing any change at this time in the existing tentative standards under the jurisdiction of Committee D-16 as referred to in last year's report,[1] it is deemed more desirable because of the increase in the sub-committees and in their personnel and the additional practical experience which will now be brought to bear upon the committee's work, to defer definite recommendations for another year.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 596 (1928).

ACTIVITIES OF SUB-COMMITTEES

In the following, the committee discusses other features of its activities, in the order of the respective sub-committees, as a brief résumé of work accomplished and as a forecast of the coming year's program.

Sub-Committee I on Methods of Tests (D. W. Kessler, chairman).—This sub-committee has given further attention to the absorption test with a view of determining the causes for variations noted in previous tests by various laboratories on the same specimens of slate. The four samples of slate, described in the 1928 report,[1] were subjected to repeated absorption tests in accordance with the Tentative Method of Test for Water Absorption of Slate (D 221 - 27 T).[2] Figure 1 shows graphically the results obtained by three laboratories on the four samples of slate of three specimens each from the repeat tests in the order given. Test Series Nos. 1 and 2 were made at the U. S. Bureau of Standards by two different operators, No. 3 was made at the Rensselaer Polytechnic Institute, No. 4 at Lafayette College and Nos. 5, 6 and 7 at Rensselaer Polytechnic Institute. The tests were made in the order shown in Fig. 1.

It seems evident from these results that repeat tests on the same specimens may be expected to give higher absorption values. The large increase in absorption shown for several specimens for three repetitions of the test has not been accounted for, but aside from this variation the increase is rather uniform in successive repetitions. The explanation of this is probably that the slate is affected to some extent by the drying process. This increase in absorption due to repeatedly heating and soaking the specimens, as established by these tests, tends to account for the variations previously noted in an effort to determine the reliability of the absorption test procedure as outlined in Method D 221 - 27 T.

Previous efforts to secure a check on this procedure by tests on different specimens of the same slates by different laboratories were equally unsatisfactory, since variations in results of nearly 100 per cent were obtained. This was attributed to variations in the specimens but in the light of the more recent data it seems that some of the variations may be due to some laboratories using higher drying temperatures than others. This phase of the test procedure evidently demands further study.

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 596 (1928).

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 972 (1927); also 1928 Book of A.S.T.M. Tentative Standards, p. 585.

Sub-Committee III on Machining and Workability (Oliver Bowles, chairman).—The work of this sub-committee, formerly known as the Sub-Committee on Hardness and Workability, which seemed to conflict with the work of Sub-Committee II on Abrasive Hardness, had been discontinued and the former Sub-Committee IX on Abrasive Sand was given features of this work and combined under the title above indicated as Sub-Committee III. This sub-committee is now at work on a number of matters connected with quarrying and milling.

Sub-Committee V on Weathering Characteristics (Charles H. Behre, Jr., chairman).—Many interesting investigations by members of this sub-committee are under way, particularly those by the chairman at the University of Cincinnati. Results of these investigations will be reported to the committee at its meeting in Atlantic City to be held during the annual meeting of the Society. At a meeting of the committee, the point was emphasized that the term "weathering" in the case of slate should not be confused with the usual use of this term, which is taken to mean disintegration, because, in the case of roofing, for instance, the "weathering" or change of color of slate is often a feature desired by architects just as it is in the case of certain stones or brick for the facing of buildings. The work of this sub-committee is being conducted in harmony with other committees of the Society which are considering the "weathering" of other materials.

This report has been submitted to letter ballot of the committee, which consists of 23 members; 21 members returned their ballots, of whom 20 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

WILLIAM B. PLANK,
Chairman.

D. KNICKERBACKER BOYD,
Secretary.

REPORT OF COMMITTEE D-18

ON

NATURAL BUILDING STONES

Committee D-18 held one meeting during the past year apart from which all of the subject matter that has been worked on by the several sub-committees has been handled through correspondence.

The activities of this committee during the past year have been largely at a standstill owing principally to the need for completing the assembly and cross-indexing and mimeographing of its file of reference data, based upon the bibliography of existing data, which it had prepared. This work is now practically completed.

It is expected that Committee D-18 will have completed in final form during the coming year for formal approval as a tentative standard at or prior to the next annual meeting of the Society the four sections of its program referred to in detail under activities of sub-committees: namely, *A*, Uniform Nomenclature Applying to the Stone Industry; *D*, Methods of Physical Tests for Stone; *H*, Uniform Names and Descriptions of Stone Surface Finishes; and *L*, Uniform Methods of Cubing Stone.

As the result of a fairly comprehensive and exhaustive series of research studies on the effectiveness and relative merits of various elastic caulking compounds in stone work, Mr. H. H. Dutton, a member of the committee, is presenting at this annual meeting a paper on this important subject entitled: "Tests of Elastic Caulking Compounds."[1]

ACTIVITIES OF SUB-COMMITTEES

The first installment of definitions and terms required for the nomenclature applying to the work of this committee was prepared last year and sent out for approval of the committee and has been approved by ballot vote. These definitions will be submitted to Committee E-8 on Nomenclature and Definitions for review. The second installment of definitions and terms covering in general the physical properties, fabricating practice and constructional usage of stone have been prepared and are now ready for study by the committee.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II (1929).

Sub-Committee III on Testing Procedure (H. C. Peffer, chairman).—The first preliminary draft of proposed methods of physical tests for building stone has been prepared and sent to the committee membership for study and suggestions and as now revised will soon be submitted for letter ballot vote and will then be recommended for publication as a tentative standard.

Sub-Committee IV on Uniform Cubing of Stone (H. H. Sherman, chairman).—Considerable data on the methods of cubing stone now in use has been prepared by the several producer members of the committee and as soon as this has been properly assembled and edited it will be ready for transmittal to the members of Committee D-18 for comment and suggestion.

Considerable data have also been prepared by representatives of the several branches of the stone industry, regarding the various surface finishes used on their material, together with the most appropriate names for and descriptions of these surface finishes. A new Sub-Committee V has been appointed to further develop this subject.

This report has been submitted to letter ballot of the committee, which consists of 19 members; 15 members returned their ballots, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

F. Y. JOANNES,
Chairman.

H. S. BRIGHTLY,
Secretary.

REPORT OF COMMITTEE E-1
ON
METHODS OF TESTING

The Report of Committee E-1 for the past few years has emphasized the importance of giving greater consideration to the development of test procedures and to the way in which these procedures are described. This applies not only to the study of methods of test in order to assure that the method is determining the fundamental property of the material desired but also that the procedures as described are explicit and complete in all respects. Mention was made in the 1928 report of the work of the Editorial Committee whereby it was planned to review descriptions of incidental tests, or tests where little correlation seemed necessary, with the thought in mind that where the review showed that the test procedure was complete in all details and set forth in a clear manner, the test procedure receive the formal approval of Committee E-1. Considerable progress has been made during the past year in this phase of the committee's work and approximately fifteen descriptions of tests have been approved. The reviews of additional test procedures have been completed and discussions will be entered into with the standing committeees concerned during the coming year in respect to minor modifications that may be necessary in the descriptions of the tests as published.

The technical committees, organized to consider specific types of tests, have been quite active during the year. No specific recommendations concerning standards are being presented at this time but much preliminary work has been carried out and the fundamental considerations involved in the tests are receiving consideration.

Some changes in personnel have taken place, as for example, the appointment of Mr. C. S. Reeve to succeed Mr. A. W. Dow as chairman of the Technical Committee on Volatility, and the appointment by the Executive Committee of Mr. P. H. Bates as a member of the Advisory Committee, due to the resignation of Mr. A. W. Dow. A further vacancy now exists in the Advisory Committee due to the resignation of Mr. A. T. Goldbeck. Mr. J. P. Hubbell has accepted the chairmanship of the Technical Committee on Size and Shape.

The work assigned to the Technical Committee on Mechanical Testing has continued to grow, necessitating the organization of additional sections. Two new sections, one on Elastic Strength and the other on Effect of Speed in Mechanical Testing, are now being organized. A third section on Indentation Hardness was authorized a year ago and organized during the year. The Technical Committee on Impact Testing will also function as a section of this technical committee, the chairman of which, Mr. E. B. Smith, had previously resigned.

Index to Methods of Testing.—Believing that an index to all methods of test of the Society would be of assistance to the individual standing committees and would also be helpful in the general correlation of methods of test, such an index was prepared during the past year and issued in mimeographed form. That this index filled a distinct need is indicated by the fact that the edition was completely exhausted in meeting requests for it that were received. Standing committees, in developing a procedure for making a given determination, upon reference to this index may learn of procedures for similar determinations that have already been prepared by other standing committees. These other descriptions may serve as a guide or even as a basis for the new determination desired. It is planned to issue a revised index during the next few months which will again be furnished to the representatives of standing committees serving on Committee E-1 and to committee officers and to other members of the Society on request.

ACTIVITIES OF TECHNICAL COMMITTEES

In view of the dual function of the technical committees, namely, the consideration of types of test from a fundamental standpoint and the correlation of existing descriptions of test procedures, the technical committees and the sections thereof are organized to consist of indiivduals especially interested in the test who may or may not be the representatives of the standing committees concerned, together with the representatives of all standings committees interested in a given type of test. This scheme of organization is peculiarly fitted to handle the problems before Committee E-1 and has functioned very well as is indicated by the progress made by the several technical committees as set forth below.

Technical Committee I on Mechanical Testing (H. F. Moore, chairman).—The sections of the technical committee have been quite active during the year and have reported progress as follows:

The Section on Tension Testing, under the chairmanship of R. L. Templin, is making considerable progress on the study of the methods before it and has taken preliminary steps toward getting together a summary of general principles to be followed in making a tension test.

The Section on Compression Testing has completed its organization, under the chairmanship of W. A. Slater, with the following personnel:

W. A. Slater (chairman)
M. O. Fuller
T. R. Lawson
J. C. Pearson
M. O. Withey
C. A. Wright

Representative of Committee B-2on Non-Ferrous Metals and Alloys
" " B-3 on Corrosion of Non-Ferrous Metals and Alloys
" " C-1 on Cement
" " C-3 on Brick
" " C-9 on Concrete and Concrete Aggregates
" " C-10 on Hollow Masonry Building Units
" " C-11 on Gypsum
" " D-7 on Timber
" " D-9 on Electrical Insulating Materials
" " D-11 on Rubber Products
" " D-16 on Slate
" " D-18 on Natural Building Stone

The Section on Indentation Hardness, under the chairmanship of J. R. Townsend, has carried out a considerable amount of work which it is expected will lead to standard methods of Rockwell hardness testing, aiming to secure generalized methods in so far as possible. Several papers being presented at this annual meeting are in part the result of the activities of the section.

The Section on Bend Testing, under the chairmanship of A. B. Kinzel, has developed a proposed method of bend testing. The report of this section, together with the proposed method of bend testing, is appended hereto for publication as information.

The Section on Flexure Testing, previously authorized, has not yet completed its organization.

The Section on Thin Sheet Metals, which was quite active in the development of a standard test specimen for tension testing, has lost its chairman, Mr. H. C. Knerr, through resignation and a new chairman is still to be appointed.

As mentioned previously, two additional sections, one on Elastic Strength and the other on Effect of Speed in Mechanical Testing, have been authorized. In addition, the technical committee has been asked to organize the Technical Committee on Impact Testing as a section of the Technical Committee on Mechanical Testing.

Technical Committee III on Consistency, Plasticity, Etc. (E. C. Bingham, chairman).—The committee has been formulating a series of definitions concerning deformation and flow which are being presented in the form of a technical paper by the chairman at this annual meeting of the Society in order to elicit discussion.[1] The definitions in their preparation have already received the consideration of groups of scientists, and as a result of the presentation of the paper further discussion is expected of the fundamental definitions. Steps are being taken to determine to what extent existing tests can be improved advantageously to conform with the fundamental definitions and it is hoped that those interested will volunteer to undertake certain portions of the necessary experimental work.

Technical Committee IV on Size and Shape (J. P. Hubbell, chairman).—Two sections of the technical committee have been active during the year, one on Sub-Sieve Sizes dealing with extremely fine material and the other on Coarse Screens. The report of the technical committee, covering the activities of these two sections, is appended hereto. From this report it will be noted that the Section on Sub-Sieve Sizes contemplates establishing a fellowship either at Columbia University or at Harvard University, to study indirect methods as practiced in various laboratories and to try to correlate the results with measurements made by the fundamental microscopic method. The section hopes to interest a number of industries to raise the necessary funds.

The Section on Coarse Screens has practically reached an impasse in its endeavors to arrive at agreement on the use of one of the two types of screen in current use for coarse aggregates, namely, the round-hole screen and the square-mesh screen. The round-hole screen has been employed in the road materials field whereas for general concrete purposes the square-mesh screen has largely been employed. Until one or the other system of screens is agreed upon the committee proposes to establish standard specifications for both types of screen.

Technical Committee V on Methods for Density (A. T. Goldbeck, chairman).—The report of this technical committee, proposing certain modifications in the definitions for specific gravity appearing in the Standard Definitions of Terms Relating to Specific Gravity (E 12 – 27), which the committee is using as a basis for its work, is appended hereto.

Technical Committee VI on Determination of Water (W. H. Fulweiler, chairman).—Certain changes are being recommended this year by Committee D-2 on Petroleum Products and Lubricants in respect to the Standard Method of Test for Water in Petroleum Products and Other Bituminous Materials (D 95 – 28), which method was originally developed under the jurisdiction of the technical committee. These modifications have been referred to the technical committee and this committee finds them to be satisfactory.

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[1] E. C. Bingham, "Some Fundamental Definitions of Rheology," *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II (1929).

Technical Committee VII on Volatility.—Mr. C. S. Reeve has recently been appointed to the chairmanship of this technical committee to succeed Mr. A. W. Dow, who resigned. Accordingly no further developments have transpired in the work of this committee that would warrant reporting upon at the present time.

Technical Committee VIII on Chemical Composition (G. E. F. Lundell, chairman).—The report of this technical committee is appended hereto. As indicated in this report the work under the jurisdiction of this committee covers methods applying to materials of a very varied nature and accordingly, rather than to hold meetings of the committee to discuss matters that would be of interest to a limited number of those in attendance, much of the work has been handled by correspondence.

The only matters subject to letter ballot in the committee are the approval of the procedures reviewed by the Editorial Committee and upon which agreement has been reached between the Editorial Committee and the standing committee concerned. These procedures are the following:

Test Procedure for the Determination of Percentage Foots, appearing in:
  Tentative Specifications for Soya Bean Oil, Raw or Refined (D 124 – 22 T);
  Standard Specifications for Perilla Oil, Raw or Refined (D 125 – 23);
  Standard Specifications for Raw Linseed Oil (D 234 – 28).
Test Procedure for Determination of Water-Soluble Matter in Pigments, appearing in:
  Standard Methods of Routine Analysis of Dry Red Lead (D 49 – 28);
  Standard Methods of Routine Analysis of Yellow and Orange Pigments Containing Chromium Compounds, Blue Pigments and Chrome Green (D 126 – 27);
  Standard Methods of Routine Analysis of Titanium Pigments (D 186 – 27);
  Tentative Methods of Routine Analysis of White Linseed Oil Paints (D 215 – 28 T).
Description of Procedure for Strain Test, appearing in:
  Standard Specifications for Naval Brass Rods for Structural Purposes (B 21 – 27);
  Standard Specifications for Brass Pipe, Standard Sizes (B 43 – 24);
  Standard Specifications for Seamless Admiralty Condenser Tubes and Ferrule Stock (B 44 – 24);

Standard Specifications for Seamless 70–30 Brass Condenser Tubes and Ferrule Stock (B 55 - 25);
Standard Specifications for Seamless Muntz Metal Condenser Tubes and Ferrule Stock (B 56 - 25);

Test Procedure for Determination of Rosin, appearing in:
Tentative Methods of Routine Analysis of White Linseed Oil Paints (D 215 - 28 T);
Tentative Methods of Testing Shellac Varnish (D 214 - 27 T).

Test Procedures for Added Coloring Matter in Pigments, appearing in:
Standard Methods of Routine Analysis of Dry Red Lead (D 49 - 28);
Standard Methods of Routine Analysis of Yellow, Orange, Red and Brown Pigments Containing Iron and Manganese (D 50 - 27);
Standard Methods of Routine Analysis of Yellow and Orange Pigments Containing Chromium Compounds, Blue Pigments and Chrome Green (D 126 - 27).

The result of the letter ballot on these test procedures is indicated below. It is felt that the approval of these procedures represents a substantial beginning in the general review of all of the methods of the Society. The work of the committee should proceed with greater facility as time goes on since as a result of the committee's activities in the past the methods now being developed are in more satisfactory form that was formerly the case. In addition, many of the earlier methods of the Society are being revamped by the standing committees concerned, in order to make them more complete and to cover more adequately the determinations involved.

Items	Affirmative	Negative	Not Voting
1. Test Procedure for Determination of Percentage Foots	14	0	19
2. Test Procedures for Added Coloring Matter in Pigments	13	0	20
3. Test Procedure for Determination of Rosin	14	0	19
4. Description of Procedure for Strain Test	19	1	13
5. Test Procedure for Determination of Water-Soluble Matter in Pigments	14	0	19

This report has been submitted to letter ballot of the committee, which consists of 46 members; 29 members returned their ballots, with the following results: Advisory Committee, 3 affirmative and none negative; Standing Committees, 26 affirmative and none negative.

Respectfully submitted on behalf of the committee,

W. H. FULWEILER,
Chairman.

R. E. HESS,
Ex-officio Secretary.

REPORT OF SECTION ON BEND TESTING

General Considerations.—For some time, because of its simplicity, the bend test has been used as a rough-and-ready test for ductility. Specifications for structural steels and similar materials require a bend test. Modern publications on materials of construction refer to the bend test as a rough-and-ready test of ductility and in all instances the angle of bend is taken as a measure of ductility. It is also stated that the bend test is a more severe test of ductility than the tension test. Methods of starting and closing the bends vary considerably and this, together with the use of the bend angle as a measure of the performance, accounts for many of the discrepencies in this test. The committee has investigated the problem of bend testing both from the bibliographical and experimental sides. A selected bibliography including some 106 items has been compiled and experimental investigations have been initiated. The following paragraphs outline the present status of this work and include some results arrived at by the committee.

Reasons for Using the Bend Test.—Although it is generally agreed that the bend test is a more severe test for ductility than the tension test and that it has a very definite place in the testing of materials, the committee investigated the basis for this opinion. Several steels were obtained in pairs in which the tensile strength, yield point, reduction of area and elongation in 2 in. of each pair were practically identical but in which the impact values differed materially. These were subjected to bend tests. It was found that marked differences in performance on bending resulted, even though the tensile properties were identical. The differences were not as marked as obtained in the impact test but were sufficiently great to show that the bend test measures a combination of properties not necessarily the same as those measured in the static tension test. It is believed that this is due to the fact that in the bend test the material is under three-dimensional stress with the fibers constrained to a much greater degree than in the tension test. Thus, there is a definite technical reason for continuing the use of the bend test.[1] Moreover, ease of testing and the lack of the necessity of elaborate or special equipment is highly desirable and constitute another justification of the bend test. In addition, the bend test has been found to yield valuable quantitative and comparative information in many special applications, notably in welded coupons. This application is so important that a special reference to it is deemed advisable in this connection.

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[1] It should be noted that this fact was only brought out by the new method of bend testing which will be described later in this report and that the usual method is too rough to show the difference.

For some time the only quantitative data on the ductility of a weld were obtained from the tension test. If only low-carbon steel plate and low-carbon steel welding rods and one method of welding were used universally, the ductility figures obtained from the tension test could be used for comparative purposes. However, with the numerous types of welding rods and base metals available, experience has shown that the percentage elongation values obtained from the tension test on welded coupons do not represent the true ductility of the weld metal. When the fracture of a welded coupon occurs outside the weld, the percentage elongation measured over the weld is less than the maximum and gives no indication of how much more extension is possible before fracture. From this we may conclude that the percentage elongation in the tension test does not yield definite data as to the ductility of the weld metal when fracture does not occur in the weld. In the case of low-strength weld metal with high-strength plate when fracture occurs in the weld, severe local stresses are imposed on the weld metal due to the action of the unyielding base metal so that even in this case the tension test does not yield reliable information as to the ductility of the weld metal itself even though a shorter gage length than usual is used. The new quantitative bend test on the contrary yields definite quantitative data as to the ductility of the weld metal proper.

Discussion of Present Methods of Bend Testing.—Two general methods of bend testing have been in use for some time. One of these consists in wiping the specimen around a pin of definite diameter, this diameter bearing a relation to the thickness of the material being tested. The other method is to force the piece between rollers by means of a tup, the distance between the rollers and the radius of the tup bearing a definite relation to the thickness of the specimen. In each case the specimen is bent to fracture or to a V and the performance of the specimen is then measured by the angle of bend. These two methods essentially use the same principles and are open to the same serious objections. It is impossible to quantitatively duplicate results and there is no relation between the performance of specimens of the same material but of different thicknesses. Failure is caused by lack of elongation in the outside fibers and there is no relation between the angle of bend and the fiber elongation. These difficulties are due in part to the fact that stress concentration exists at the point of contact with the pin or tup. Moreover, due to the stress-strain characteristics of metals, it is impossible to bend the specimens in such a way that the inside of the bent specimen remains in contact with the pin. In steel this is accentuated by the yield point. When the outside fibers at the center of the bend are subjected to a certain strain they elongate appreciably without proportionate increase of stress, and local kinking results. When the specimen leaves the pin, local stresses are set up so that the final shape bears little relation to the diameter of the pin used. Experiments show that up to approximately 90 deg. of contact on the pin this effect is not serious but it becomes very evident beyond this point. Obviously, therefore, any bending angle beyond 90 deg. is not an index of the bending characteristics of the material. The degree at which contact is lost varies, depending on the thickness of the material and the diameter of the pin used. Another objection to the method is that it is extremely difficult to perform the test without putting the whole specimen in tension and this of course seriously affects the bending characteristics. As previously mentioned these objections apply equally to the pin and tup method.

PROPOSED METHOD OF QUANTITATIVE BEND TESTING

Due to the difficulties with the present methods of testing, experiments were performed to arrive at a more satisfactory method. The method found to give consistent quantitative results consists essentially in bending the specimen by means of couples at the ends without restraint by pins or other means at the point of maximum bending. This is followed by measurements of the elongation of the outside fibers at the point of maximum bending. This is known as free bend with measurement of the fiber elongation. Although most of the work on this test has been carried out on iron and steel, sufficient work has been done with hardened copper and other non-ferrous metals to show that it is entirely applicable. It is obvious that if the specimen bends flat upon itself without fracture no quantitative data may be obtained. Work on producing failure in such highly ductile materials by means of a hole in the center of the specimen is under way, and will be reported at a subsequent date. This work is based on the well-known fact that the strain at the edge of a hole is three times that in the continuous metal.

Preparation of Specimens.—For quantitative results in which the final figure is independent of the thickness of the specimen, rectangular specimens with widths at least three times the thickness should be used. The edges should be smoothed so that the fracture does not take place at the edge. The outside surfaces of the specimen should be smooth and free from local defects. The length may vary with the thickness of the piece and is unimportant provided it is long enough to perform the bonding operation. Round bars may be tested in this method but the results will only be comparative, as for the same material the fiber elongation is found to vary slightly with the diameter.

Method of Starting the Bend.—In order to start the bend any stress or strain at the point which eventually will have the greatest bending should be avoided. This may be accomplished by holding the specimen in a vise about one-third from the end, producing an initial bend at this point by hammer blows, or the specimen may be set up on cross supports and initial bend started in this way at the third points. The initial bend should be far enough from the final point of maximum bending so as not to affect it. This is performed on both ends of the piece.

Method of Closing the Bend.—The specimen with initial bends on each end is placed in a vise or press as a strut and compression applied at the ends. The press is closed until failure of the outside fibers occurs. The speed of closing as well as the continuity of the applied pressure has been investigated and it has been found that the speed is not a factor provided actual shock is not used. The continuity of closing and the speed may be varied at will without affecting the results within the limits of accuracy expected, namely, ±5 per cent of the value of the fiber elongation.

Measurement of Fiber Elongation.—The performance of the specimen in the bend test is then evaluated by the measurement of the outside fiber elongation. The most direct method of performing this is to place gage marks on the specimen before bending and to measure the final length directly with a flexible scale.

Experiments have shown that for consistent results the gage length in which the elongation is measured should be at least 0.3 in. and not greater than 1 in. except in the case of plate from $\frac{1}{4}$ to $\frac{1}{2}$ in. thick, in which case the maximum gage length used should be not more than twice the thickness of the plate. With material less than $\frac{1}{4}$ in. thick, the difficulties in measurement of elongation are so great that to date the committee is not prepared to make any recommendations. The committee is continuing the study of this problem and hopes to make recommendations at a future date.

Any other method of measuring the fiber elongation which gives the same values as this direct method may be used. For example, in some cases it may be objectionable to put gage marks on the specimen. In this event the radius of the outside of the specimen may be measured and the elongation calculated.

For simplified operation a bend extensometer has been developed which reads fiber elongation directly when placed on the curved surface. Any such method is satisfactory, if, as above stated, the values obtained are consistent with the method of direct measurement. In using other methods than the direct measurement, care should be taken that the gage length on which the results are based, is consistent with those here given.

Advantages.—The consistency of the results is remarkable and constitutes the main advantage. Not only do similar specimens of a given material give the same results but the same mterial when tested in various thicknesses gives the same results showing that the test measures inherent properties of the material rather than a composite of its properties and geometric form. So far as the committee has been able to find out, this is the only method of bend testing which gives reliable quantitative data either for homogeneous or non-homogeneous specimens.

Test Data.—In substantiation of the statements made in this report, the committee offers the following test results:

Showing Difference in Bend Without Difference in Tensile Properties:

SPECIMEN	YIELD POINT, LB. PER SQ. IN.	TENSILE STRENGTH, LB. PER SQ. IN.	ELONGATION IN 2 IN., PER CENT	REDUCTION OF AREA, PER CENT	IZOD VALUE, FT-LB.	BEND, PER CENT
No. 1	36 000	55 000	32	64	49	125
No. 2	37 000	54 000	33	62	6	34

Showing Measured Ductility of Different Welds in Tension Test and Bending:

TEST	ELONGATION IN 2 IN., (TENSION TEST), PER CENT	BEND ELONGATION, PER CENT	REMARKS
No. 1	11	19	Standard
No. 2	6	20	Standard
No. 3	7	30	Special
No. 4	5	36	Special

Elongation in Bend Test of Bars of Two Steels and of Various Dimensions:

THICKNESS, IN.	WIDTH, IN.	BEND VALUE	
		MATERIAL A	MATERIAL B
0.25	0.25	48	..
	0.50	44	82
	0.75	37	75
	1.00	39	74
	1.50	39	77
	2.00	37	72
0.475	0.50	46	..
	0.75	44	80
	1.00	39	75
	1.50	38	70
	2.00	40	74

THICKNESS IN.	WIDTH, IN.	BEND VALUE MATERIAL A	BEND VALUE MATERIAL B
0.50	0.75	45	..
	1.00	43	..
	1.50	39	71
	2.00	39	74
0.75	0.75	46	..
	1.50	42	..
	2.50	37	..
	3.00	38	..

NOTE.—It will be noted that when the width is at least three times the thickness, check results are obtained on the same material.

Showing Effect of Speed of Closing Bend:

	SPEED	DIMENSIONS, IN.	ELONGATION, PER CENT
Material A	0.025 in. per minute	0.25 by 1.00	39
		0.50 by 1.50	40
	2 in. per minute	0.25 by 1.00	37
		0.50 by 1.50	38
	Vise (intermittent)	0.25 by 1.00	38
		0.50 by 1.50	37
Material B	0.025 in. per minute	0.25 by 1.00	74
		0.50 by 1.50	70
	2 in. per minute	0.25 by 1.00	76
		0.50 by 1.50	71
	Vise (intermittent)	0.25 by 1.00	74
		0.50 by 1.50	73

CONCLUSIONS

1. The committee believes that the method of free bending with fiber elongation as above outlined is a satisfactory method of bend testing, eliminating the objections to the old methods of bend testing and yielding definite quantitative data, and invites discussion of this method in anticipation of formally presenting it as a tentative standard.

2. The committee recommends that Committee E-1 consider this method of bend testing and evaluation.

Respectfully submitted on behalf of the section,

A. B. KINZEL,
Chairman.

[For Discussion on Bend Testing see page 503.—ED.]

REPORT OF TECHNICAL COMMITTEE IV ON SIZE AND SHAPE

The active work of the committee during the past year has been carried on by two sections: namely, that on Sub-Sieve Sizes, under the chairmanship of G. S. Haslam, and that on Coarse Screens, under the chairmanship of F. H. Jackson. Reports from these sections are given below.

SECTION ON SUB-SIEVE SIZES

The work of the past year has been to correlate a number of reports submitted by various members of the committee giving results of the measurement of selected samples of pigments. The agreement of microscopic results is far better than any other single method and gives indications that within the year the committee will be in a position to present requirements for a standard method for the determination of particle size by means of the microscope. There are few details which need to be established and the present program of the committee should accomplish this end.

A round-table discussion of the science of particle size determination was held at Atlantic City during the 1928 annual meeting of the Society. While the discussion did not serve to establish any new methods of tests it did bring members of the committee and others interested in this science into close personal contact. A great many new ideas were presented for consideration of the committee.

A nucleus group, composed of Messrs. Green, Work, Wells and Haslam, was appointed to draw up a program for future work of the committee. This program will be almost entirely a microscopic program as the committee has gone on record that the foundation of the whole subject of fine particle size measurements must be based on a microscopic measurement. Another project tentatively planned to begin in September, 1930, is to establish a fellowship either at Columbia University or Harvard University to support a graduate student who will study indirect methods as practiced in various laboratories and try to correlate the results with measurements made by the fundamental microscopic method.

SECTION ON COARSE SCREENS

The Section on Coarse Screens held a meeting in Chicago during the Spring Group Meetings of the Society, at which time the present status of the particular problem upon which it has been working since its organization two years ago was thoroughly discussed. It was decided that the report for this year should take the form of a review of the present situation in the Society as regards the adoption of a standard testing screen for aggregate sizes larger than No. 4, and should include a discussion of the efforts made by the section to secure a decision based on technical grounds as well as a discussion of the reason why it seems impossible to secure agreement of the interested committees in the matter.

At the present time there are a number of standard and tentative standard specifications and methods of test for aggregates, all of which originated in Committee D-4 on Road and Paving Materials, and in all of which round-hole screens are recognized as standard.

There are also two standard and tentative standard specifications and methods of test for aggregates which originated in Committee C-9 on Concrete and Concrete Aggregates, and which recognize the square-mesh sieve as the standard.

In the report of the section for 1928, there were presented the results of a series of tests made for the purpose of determining whether either of the present standard methods of determining size possessed any advantages from the standpoint of accuracy. These tests indicated that unavoidable errors due to sampling, etc., overshadowed any theoretical advantages either type might possess and that, for all practical purposes, the two types of aperture could be considered as giving equally concordant results. It was therefore necessary to base the recommendations of the section upon other considerations, such as the current use of testing sieves and screens, relative costs of manufacture, replacement costs, etc. As the result of such considerations, the committee last year recommended to Committee E-1, by a vote of eight affirmative to five negative, that round-hole screens be considered as standard types for testing purposes. This recommendation was considered by Committee E-1 at its meeting in April, 1928, and was passed on to the various technical committees concerned for comment.

At the recent Chicago meeting the attitude of Committees C-9 and D-4, as shown by their comments on this report, was discussed. It developed that Committee D-4 was still strongly in favor of using round-hole screens and that it had, at its last meeting, reaffirmed its decision in this regard. Committee C-9 had also considered the report and had expressed itself still as strongly in favor of square-mesh sieves, with the understanding, however, that in the event it was found impossible to standardize square-mesh sieves, standards governing both types of aperture be prepared. It has been apparent from the beginning that the two technical committees concerned are deadlocked on this matter in so far at least as the adoption of a single standard is concerned. The only alternative would then be to recognize both types of screen openings as standard, as suggested by Committee C-9. This would require revision of all of the existing standards by the insertion in each of equivalent size requirements for each type of testing screen as well as the preparation of standard specifications for testing screens of each type, including tolerances in dimensions, etc. The section is extremely reluctant to take this action because it feels that it is inconsistent with one of the primary functions of the Society, that is, the simplification and unification of standards.

In view of the above situation, the section asks for instructions as to the procedure which should be followed during the coming year.

SECTION ON FINE SIEVES

A third section has been in existence but has been more or less inactive, namely, that on Fine Sieves. The chairman hopes to be able to get some active work started in this section during the coming year on standard methods of using testing sieves. Apparently the present standards for the sieves themselves have been satisfactory.

Respectfully submitted on behalf of the technical committee,

JOHN P. HUBBELL,
Chairman.

REPORT OF TECHNICAL COMMITTEE V ON METHODS FOR DENSITY

The Technical Committee on Methods for Density, at the last meeting held at Atlantic City, June, 1928, thoroughly discussed the present definitions relating to specific gravity and as a result of that discussion it was felt by the committee that the following revision should be made in the definitions appearing in the present Standard Definitions of Terms Relating to Specific Gravity (E 12 – 27):[1]

In those cases where temperature of the material and water are identical and are now stated in the definitions as $x°$ C., it is felt that the temperature should be stated as $\frac{x° C.}{x° C.}$

Section 2.—It is felt that the words "gas free" should be inserted after the words "volume of" in the third line of this paragraph.

Section 3.—It is felt that the following note should accompany this paragraph, "apparent specific gravity (of solids)":

Note 4.—Gas-free distilled water is not specified in the definitions for Apparent Specific Gravity and Bulk Specific Gravity because this refinement is not necessary.

After some discussion, the committtee felt that the terms defined would be clarified if an example were given to accompany each of the four cases and it recommends that such an example be given.

It is hoped that by the end of the year the committee will have agreed upon proper definitions of the various terms and will then be able to proceed with the outline of the essential principles for the determination of density and the examination of the individual specifications to determine this conformity with these principles.

Respectfully submitted on behalf of the technical committee,

A. T. Goldbeck,
Chairman.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 932.

REPORT OF TECHNICAL COMMITTEE VIII ON CHEMICAL COMPOSITION

Technical Committee VIII on Chemical Composition has held no formal meeting during the year. This was due primarily to the chairman's hesitation in calling a meeting of mixed interests for the purpose of discussing highly specialized topics that are of interest to only one or two members of the committee. The chairman has therefore adopted the plan of calling in one or two interested members at a time for the purpose of discussing changes that seem desirable in present standard or tentative methods of analysis in which they are particularly concerned.

One such conference on silicon has been held, namely, with Mr. Cunningham, who represents Committee B-4 on High-Temperature and Electrical-Resistance Alloys. As a result of this conference it was decided to recommend changes in the following methods in which the determination of silicon is described:

Refractories (A.S.T.M. Designation: C 18 – 21)
Gypsum (A.S.T.M. Designation: C 26 – 27)
Limestone (A.S.T.M. Designation: C 25 – 27 T)
Dry Red Lead (A.S.T.M. Designation: D 49 – 28)
Ultramarine Blue (A.S.T.M. Designation: D 126 – 27)
Tungsten Steel (A.S.T.M. Designation: A 55 – 24)
Ferro-Silicon (A.S.T.M. Designation: A 104 – 27)
Pig Iron (A.S.T.M. Designation: A 64 – 27)

A like conference has been held with Mr. Smither, who represents Committee D-1 on Preservative Coatings for Structural Materials, concerning methods for the determination of lead, and recommendations concerning these methods will be made.

The methods for manganese, phosphorus, and the like will next be treated, and in the course of two years considerable progress in all of the methods should be made.

The technical committee wishes to pass upon all methods of chemical analysis before they are advanced to standard. Revisions of methods of analysis can be made more easily before, than after, publication, and the work is much less.

Respectfully submitted on behalf of the technical committee,

G. E. F. LUNDELL,
Chairman.

DISCUSSION

MR. L. B. TUCKERMAN[1] (*presented in written form*).—It is certain that if the numerical results from bend tests are to be incorporated as important factors in specifications, some standard procedure different from the usual practice to-day must be developed. It would seem desirable also, so the Report on Bend Testing proposes, to develop a test in which the bend was uninfluenced by such uncertain factors as friction on a mandrel.

The report is somewhat bewildering. If I understand it correctly, by applying an eccentric axial load on a specimen, it is bent "by means of couples at the ends" until, "failure of the outside fibers occurs," and then the elongation of the outside fibers is measured at the point of maximum bending. In this test the eccentricity at which the load is applied, the width of the specimen (provided it is at least three times the thickness), the length of the specimen (provided it is long enough to permit bending), the gage length over which the elongation is measured (provided it lies between 0.3 in. and 1.0 in. and is not greater than twice the thickness of the plate) and the speed of testing, all make no appreciable effect upon the value obtained. It is even possible to replace the direct measurement of elongation by a calculation from the measured radius of curvature of the outside of the bend. How this is done might be more comprehensible if the bend extensometer were described.

It seems conceivable to me that over a limited range of not too brittle materials this indifference to all the factors which are usually found to influence test results might be roughly verified, but it is hard to believe that over the wide range of materials to which bend tests might well be applied so much latitude in test conditions should not be reflected in uncertainty in the test results. At any rate it would seem desirable before proposing the method as a tentative standard that the committee should present considerable test data covering such widely different materials as duralumin, brass, structural steel, cold-rolled steel and heat-treated alloy steels, to verify this somewhat surprising conclusion.

One of the older methods of performing the bend test, in use among blacksmiths some thirty years ago, was to start the bend around a mandrel and then finish by squeezing it end-on in a vise. It does not seem to me likely that the preliminary small deformation of the outer fibers (with no local concentration of stress) would make this test differ greatly from the method proposed by the committee, but the blacksmith who taught me, taught me also that it should only be used to compare two specimens of the same size and shape.

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[1] Assistant Chief, Division of Mechanics and Sound, U. S. Bureau of Standards, Washington, D. C.

MR. A. B. KINZEL[1] (*Chairman, Section on Bend Testing, closure by letter*).—Mr. Tuckerman's remarks are appreciated and seem to bring out the fact that we have not been sufficiently emphatic in some of the statements made in the committee's report.

Providing the specimen is at least three times as wide as it is thick, the eccentricity of loading, the width of the specimen, length of the specimen and the speed of testing all have no appreciable effect upon the final value obtained within the limits within which we are working, namely, an accuracy of 5 per cent of the final value. This has been checked experimentally over a wide range of materials. It is true that if greater accuracy is assumed, these factors must be taken into consideration. The same applies to the gage length as specified.

Regarding the description of the bend extensometer, as this is a proprietary article it does not seem fitting to describe it in great detail in the report. A detailed account, including the mathematical development, appeared in *The Iron Age*, September 5, 1928.

It should be understood that the bend test as given applies to materials which will show failure in the outer fiber before bending flat on themselves. This excludes a large field including the brass mentioned by Mr. Tuckerman. Laboratory tests have been made on commercial structural steel, cold-rolled steel and heat-treated alloy steels and the conclusions given in the report have been verified.

It is true that in testing the usual shapes found in the blacksmith's shop, it is necessary to take into account the dimensions of the specimen, but it is also true that most of the specimens found in the blacksmith's shop do not comply with the specified width-three-times-thickness as brought out in the report. It is true that in principle the old blacksmith's test does not differ from the present test. The difference lies in the fact that whereas the blacksmith takes any shape whatever, and merely observes the type of bend, we find it necessary to take the specimen complying with the width-thickness ratio above stated and actually measure the fiber elongation which takes place on the outside fiber.

I should like to point out that the quantitative bend test as herein described measures a property of the material distinctly different from any measured in the usual tension test. It is appreciated that a real check on a test of this kind is its successful and satisfactory use. The committee urges all to use the test where it is applicable, and welcomes criticism.

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[1] Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y.

REPORT OF COMMITTEE E-4
ON
METALLOGRAPHY

During the year, Committee E-4 has held one meeting at Atlantic City on June 28, 1928, and another in New York City during the annual meeting of the American Institute of Mining and Metallurgical Engineers, as many members of the committee are also members of the A.I.M.E.

Sub-Committee on Selection and Preparation of Samples (E. H. Dix, Jr., chairman).—This sub-committee is reporting some developments in its preparation of specimens, as follows:

A new etching reagent described by Dix and Keller in *Mining and Metallurgy*, July, 1928, gives excellent results when used to develop the structures of wrought-duralumin type alloys, duralumin type alloy ingots and aluminum-copper alloy castings. Very good grain contrast is obtained in heat-treated duralumin type alloys without the insoluble constituents being attacked.

The new solution consists of the following: 1.0 cc. of hydrofluoric acid (concentrated); 1.5 cc. of hydrochloric acid (sp. gr. 1.19); 2.5 cc. of nitric acid (sp. gr. 1.42); and 95.0 cc. of water. Etching is accomplished by immersing the specimens in the solution for a period of from 10 to 20 seconds. The specimen is then washed free of the acid in a stream of warm water and blown dry. Care should be taken that the etched surface is not touched as this would result in the removal of some of the etching product and give an uneven stain.

The following developments in preparation of samples are presented:

Neutral sodium picrate solution has been recommended in several texts as a suitable reagent for distinguishing between carbide and phosphide in cast iron or steel. It has been stated, however, that the sodium picrate crystals should be washed with distilled water to remove the excess acid or alkali. This is a mistake, as the crystals are soluble in water. They should be washed with alcohol, which dissolves the excess picric acid or caustic soda, but not the sodium picrate crystals. It was found that about 5 g. of crystals washed thoroughly in this way and then dissolved in 25 cc. of water produced a solution that etched iron-phosphide quite clearly when used boiling for ten to twenty minutes, but did not attack cementite when used in the same way.

In the Appendix to the report of Committee E-4 for 1923,[1] a method for the identification of inclusions in steel by means of simple etching reagents was presented by Campbell and Comstock. This method has recently been modified by C. R. Wohrman, and the modified method, published in 1928 by the American Society for Steel Treating[2] has been endorsed by Campbell and Comstock as an improvement over their original method. This new aid to the identification of inclusions in steel is mentioned although it is still doubtful whether this development should as yet be presented as a standard method.

Bakelite has been suggested as a mounting material for small specimens of comparatively hard alloys such as steels. It polishes very well, and is hard enough to support the edges of such alloys better than fusible metal. It is not seriously attacked by etching reagents, though alcohol seems to dissolve it slightly. It can be obtained in a liquid form, which hardens when heated to 250° F., and the product is much improved by the application of pressure during hardening. Several laboratories are experimenting with this material.

The results of an investigation by Losana and Blasich in Italy, of methods for macro-etching high-chromium steels are given in *Chemical Abstracts*, Vol. 22, p. 3612, October, 1928. The best solution was found to be 15 per cent sulfuric acid containing 1 per cent of bromine. At 50 to 60° C. good results were obtained in ten minutes on stainless and silicon-chromium steels.

Sub-Committee II on Nomenclature and Definitions (Arthur Phillips, chairman).—This sub-committee was requested to formulate definitions of the terms "fiber in metals" and "plasticity" and has submitted two definitions which are now receiving consideration by the committee.

Sub-Committee III on Thermal Analysis (Howard Scott, chairman).—This sub-committee shortly expects to have a revised Tentative Standard for Thermal Analysis for consideration by the committee. It is accordingly recommended that the present Tentative Recommended Practice for Thermal Analysis of Steel (E 14 – 25 T) be continued as tentative for another year.

Sub-Committee VI on X-ray Crystal Analysis (Zay Jeffries, chairman).—The report of this sub-committee is appended hereto.

Committee E-4 has approved the sub-committee's recommendation that the Tentative Recommended Practice for Radiographic Testing of Metal Castings (E 15 – 26 T)[3] be advanced to standard.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 23, Part I, p. 521 (1923).

[2] *Transactions*, Am. Soc. Steel Treating, Vol. 14, p. 566 (1928).

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 1093 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 838.

A special committee consisting of Messrs. Dix, Lucas, Rawdon, and C. H. Davis, chairman, has submitted a set of micrographs illustrating standard grain sizes of brass which are reproduced in Plate VII. These are recommended by the committee for publication as standard reference micrographs possibly to be included ultimately with the Standard Rules Governing the Preparation of Micrographs of Metals and Alloys (E 2 – 27). The report of this special committee is appended hereto. It should prove of great value to students and all workers in the non-ferrous alloys.

At the last meeting of the committee, a question of obtaining a good supply of polishing cloth, particularly the proper grade of broadcloth for finishing samples was discussed, and Mr. Dix, the chairman of Sub-Committee I, was authorized to investigate thoroughly the question of obtaining a supply of satisfactory cloth which would be at all times of uniform grade and to arrange for its distribution among members of the committee who wish to obtain it.

The recommendation that the Tentative Recommended Practice for Radiographic Testing of Metal Castings (E 15 – 26 T) be advanced to standard has been submitted to letter ballot of the committee with the following results:

Item	Affirmative	Negative	Not Voting
I. ADVANCEMENT TO STANDARD OF TENTATIVE RECOMMENDED PRACTICE			
Tentative Recommended Practice for Radiographic Testing of Metal Castings (E 15 – 26 T)	26	0	5

This report has been submitted to letter ballot of the committee, which consists of 43 members, of whom 31 have voted affirmatively and none negatively.

Respectfully submitted on behalf of the committee,

H. C. BOYNTON,
Chairman.

G. F. COMSTOCK,
Secretary.

EDITORIAL NOTE

The Tentative Recommended Practice for Radiographic Testing of Metal Castings was approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 3, 1929, and appears in the 1929 Supplement to Book of A.S.T.M. Standards, page 120.

REPORT OF SUB-COMMITTEE VI ON X-RAY CRYSTAL ANALYSIS

Sub-Committee VI recommends that the Tentative Recommended Practice for Radiographic Testing of Metal Castings (E 15 - 26 T)[1] be advanced to standard.

The glossary of terms relating to X-ray metallography, prepared by Mr. L. W. McKeehan and published in 1926[2] has recently been somewhat extended by Mr. McKeehan but will be published jointly by the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers and the American Society for Steel Treating. The changes are not considered sufficiently significant to suggest the reprinting of the glossary in the publications of the Society.

With the thought that it would be helpful to the members of the Society to know some of the institutions and companies now equipped with apparatus for X-ray examination of metals, the sub-committee submits the following list:

Radiography of Metals

Aluminum Co. of America, Cleveland, Ohio.
Ancel St. John X-ray Laboratory, Long Island City, N. Y.
Dick X-ray Co., St. Louis, Mo.
Dow Chemical Co., Midland, Mich.
Eastman Kodak Co., Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
General Motors Co., Detroit, Mich.
Massachusetts Institute of Technology, Cambridge, Mass.
Michigan College of Mines and Metallurgy, Houghton, Mich.
National Carbon Co., Inc., Cleveland, Ohio.
Union Carbide and Carbon Research Laboratories, Long Island City, N. Y.
United States Aluminum Co., Fairfield, Conn.
United States Army Air Service, Dayton, Ohio.
U. S. Bureau of Standards, Washington, D. C.
University of Michigan, Ann Arbor, Mich.
University of Washington, Seattle, Wash.
Victor X-ray Corporation, Chicago, Ill.
Watertown Arsenal, Watertown, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 1093 (1926); also 1928 Book of A.S.T.M. Tentative Standards, p. 838.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 582 (1926).

X-RAY DIFFRACTION APPARATUS

Aluminum Co. of America, Cleveland, Ohio.
American Rolling Mill Co., Middletown, Ohio.
American Steel and Wire Co., Cleveland, Ohio.
Ancel St. John X-ray Laboratory, Long Island City, N. Y.
Bell Telephone Laboratories, New York City.
California Institute of Technology, Pasadena, Calif.
Carnegie Institute of Technology, Pittsburgh, Pa.
Columbia University, New York City.
Cornell University, Ithaca, N. Y.
E. I. du Pont de Nemours and Co., Wilmington, Del.
General Electric Co., Cleveland, Ohio.
General Electric Co., Schenectady, N. Y.
Geophysical Laboratory, Washington, D. C.
Harvard University, Cambridge, Mass.
Industrial X-ray Research Laboratory, St. Louis, Mo.
Iowa State College, Ames, Iowa.
Lehigh University, Bethlehem, Pa.
Magnetic Pigment Co., Trenton, N. J.
Massachusetts Institute of Technology, Cambridge, Mass.
Michigan College of Mines and Metallurgy, Houghton, Mich.
New Jersey Zinc Co., Palmerton, Pa.
New York University, New York City.
Ohio State University, Columbus, Ohio.
Pennsylvania State College, State College, Pa.
Purdue University, Lafayette, Ind.
Rensselaer Polytechnic Institute, Troy, N. Y.
Syracuse University, Syracuse, N. Y.
Union Carbide and Carbon Research Laboratories, Long Island City, N. Y.
U. S. Bureau of Standards, Washington, D. C.
United States Steel Corporation, Kearney, N. J.
University of California, Berkeley, Calif.
University of Illinois, Urbana, Ill.
University of Kansas, Lawrence, Kans.
University of Michigan, Ann Arbor, Mich.
University of Minnesota, Minneapolis, Minn.
University of Rochester, Rochester, N. Y.
University of Wisconsin, Madison, Wis.
Victor X-ray Corporation, Chicago, Ill.
Watertown Arsenal, Watertown, Mass.
Western Electric Co., Hawthorne, Ill.
Yale University, New Haven, Conn.

One commercial laboratory offers a routine radiographic inspection service at a rate of approximately $10.00 per hour. Metal products examined in this laboratory include sheet, castings, and forgings of various metals and alloys.

In general it may be said that X-ray metallography is thoroughly established in research and industry. Technical papers relating to

X-ray metallography are appearing in the proceedings, journals, and transactions of the important technical societies dealing with metals in all parts of the world and in the technical press. The United States is particularly fortunate in having a number of exceptional men in universities available for the training of additional men in the use of X-ray equipment and in the interpretation of results.

Respectfully submitted on behalf of the sub-committee,

ZAY JEFFRIES,
Chairman.

APPENDIX

REPORT OF SPECIAL COMMITTEE ON STANDARD MICROGRAPHS FOR COMPARISON OF GRAIN SIZES

At the meeting of Committee E-4 in June, 1928, a special committee was appointed, consisting of Messrs. H. S. Rawdon, E. H. Dix, Jr., F. F. Lucas, and C. H. Davis, chairman, to undertake the preparation of a series of ten or more micrographs to be used as standards of comparison in the inspection of grain sizes of wrought and annealed brass and other non-ferrous alloys. Twelve micrographs were subsequently prepared by the metallographic laboratory of the American Brass Co. showing grain sizes from 0.007-mm. to 0.200-mm. diameter of average grain. Two micrographs, for grain diameters of 0.010-mm. and 0.200-mm. diameter were retaken in order to more nearly represent the values desired.

TABLE I.—RESULTS OF GRAIN COUNT ON STANDARD REFERENCE MICROGRAPHS.

INTENDED DIAMETER OF AVERAGE GRAIN, MM.	U. S. BUREAU OF STANDARDS, AVERAGE OF 2 AND 3 OBSERVERS, MM.	ALUMINUM CO. OF AMERICA, 1 OBSERVER, MM.	BELL TELEPHONE LABORATORIES, 1 OBSERVER, MM.	AMERICAN BRASS CO., 2 OBSERVERS, MM.	DIAMETER OF GRAIN, AVERAGE OF ALL OBSERVERS, MM.
0.010	[a]	[a]	[a]	0.010	0.010
0.015	0.016	0.0167	0.018	0.016	0.016
0.025	0.025	0.021	0.027	0.024	0.024
0.035	0.034	0.033	0.031	0.0345	0.033
0.045	0.045	0.044	0.043	0.046	0.045
0.065	0.069	0.066	0.071	0.064	0.067
0.090	0.088	0.091	0.092	0.090	0.090
0.120	0.122	0.122	0.122	0.122	0.122
0.150	0.144	0.149	0.152	0.147	0.147
0.200	[a]	[a]	[a]	0.197	0.197

[a] The original micrographs were replaced, consequently the 0.010 mm. and 0.200-mm. sizes were not counted by these observers.

The material used for the preparation of the specimens was cartridge brass of approximately 70–30 copper-zinc alloy. The specimens were annealed at such a temperature as to give the required size of grain at a magnification of 75 diameters. Polishing was carried out on one wheel covered with canvas to which was applied Turkish emery and water, a second wheel covered with broadcloth, the polishing mixture consisting of tripoli and water, and a third wheel also covered with broadcloth with in some cases levigated alumina and water and in other instances jewelers rouge and water. The etching in all cases was with a mixture of equal parts of ammonia and water plus a small amount of hydrogen peroxide (30 volume H_2O_2). The proportions used were about 10 parts of the ammonia and water mixture and one part of the hydrogen peroxide.

The photographs were made by means of a Bausch & Lomb metalloscope of recent design, employing a 16-mm. achromat as objective and a × 5 hyperplane eye-piece. The illuminant was a 110-volt d.c. arc lamp. The *B* Wratten filter was employed in most instances, but in some of the micrographs showing the larger grains the *K2* filter was used. The plates were in all cases the Hammer Slow that have a very fine grained emulsion and the photographic paper generally employed was Velox.

Reproductions of ten of the micrographs of the following approximate diameters of average grain size are shown in the accompanying Plate VII:

	AVERAGE GRAIN DIAMETER, MM.
No. 1 (Fig. 1 (*a*))	0.010
No. 2 (Fig. 1 (*b*))	0.015
No. 3 (Fig. 1 (*c*))	0.025
No. 4 (Fig. 1 (*d*))	0.035
No. 5 (Fig. 1 (*e*))	0.045
No. 6 (Fig. 1 (*f*))	0.065
No. 7 (Fig. 1 (*g*))	0.090
No. 8 (Fig. 1 (*h*))	0.120
No. 9 (Fig. 1 (*i*))	0.150
No. 10 (Fig. 1 (*j*))	0.200

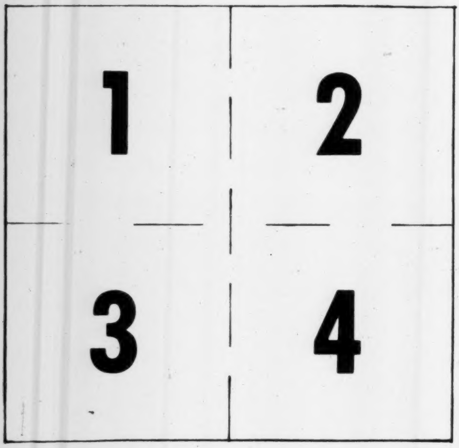
Grain counts have been made by observers at the U. S. Bureau of Standards, by Mr. Keller of The Aluminum Co. of America, by one observer at the Bell Telephone Laboratories, and by two observers of The American Brass Co. These are recorded in the accompanying Table I. It will be noted that the agreement between the observers was quite close, and the micrographs are accordingly presented as reference standards for general use.

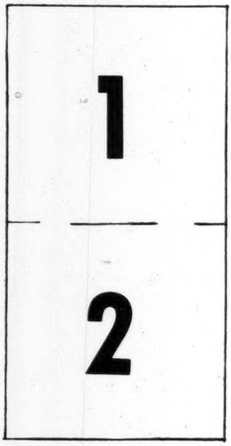
It is contemplated adding these reference standards ultimately to the Standard Rules Governing the Preparation of Micrographs of Metals and Alloys (E 2 - 27). The micrographs show a round field so as to compare with the appearance of a sample under the microscope. It is felt that these reference standards as reproduced will serve a very useful purpose.

Respectfully submitted on behalf of the special committee,

C. H. DAVIS.
Chairman.

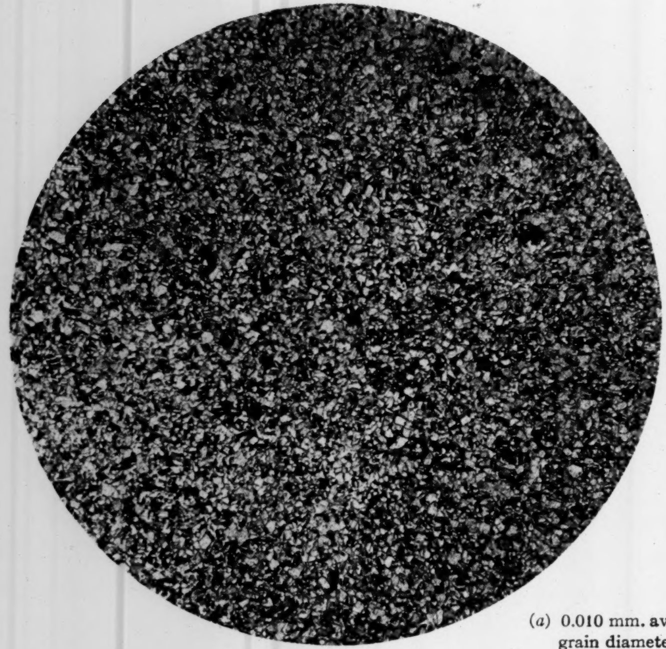
Maps on this order too large to be
are filmed clockwise beginning in t
right and top to bottom as many fr
diagrams illustrate the method.



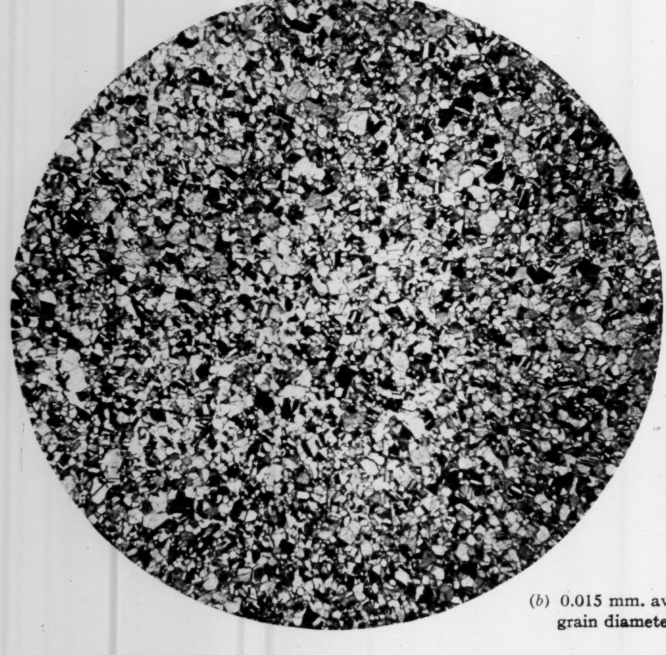


be entirely included in one exposure
n the upper left hand corner, left to
frames as required. The following

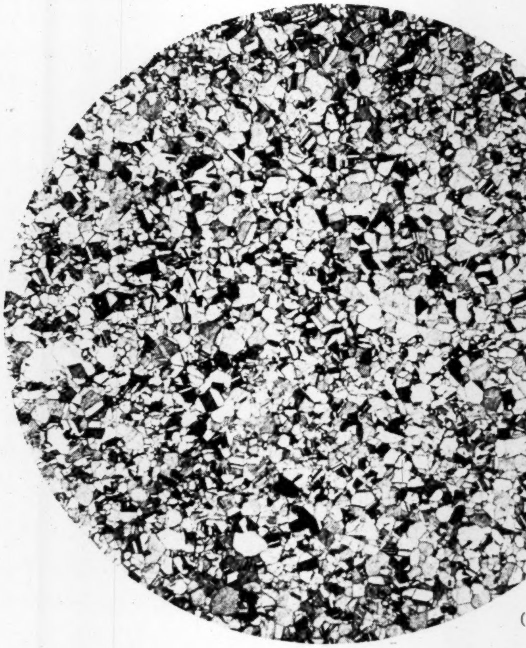
1	2	3
4	5	6
7	8	9



(*a*) 0.010 mm. average grain diameter.



(*b*) 0.015 mm. average grain diameter.



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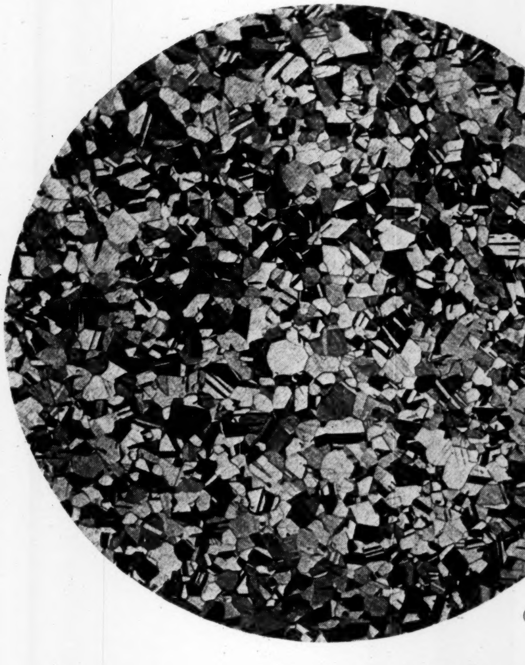

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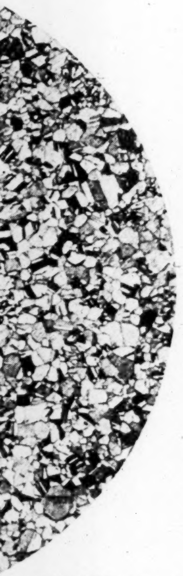
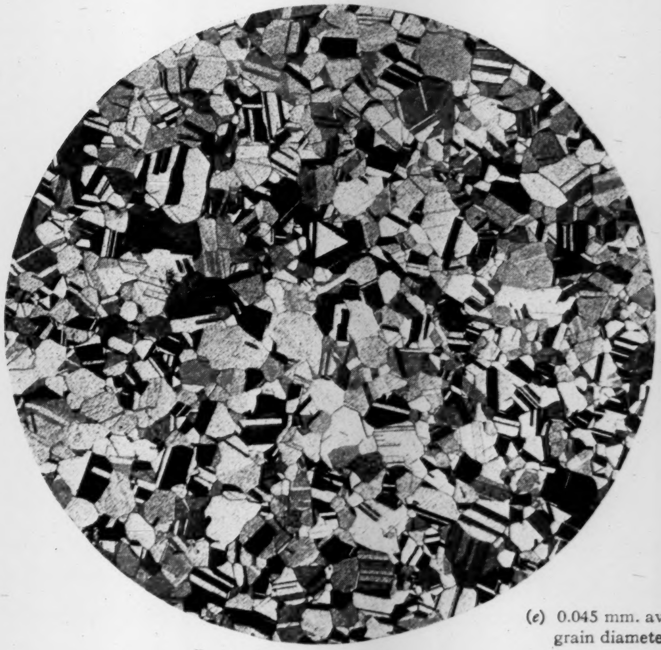
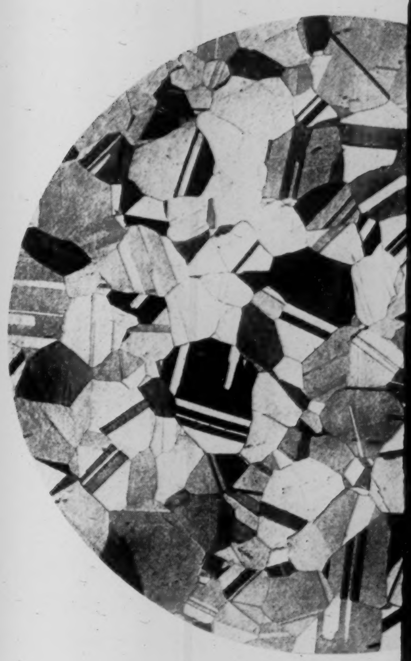
FIG. 1.—Grain Size Standa

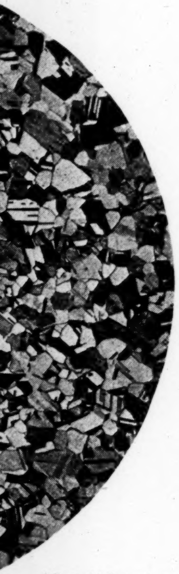


(*c*) 0.025 mm. average grain diameter.

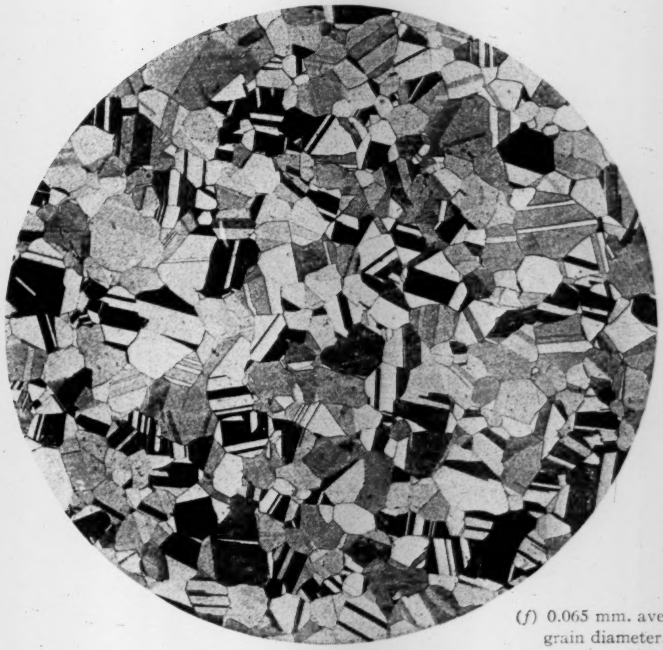


(*e*) 0.045 mm. average grain diameter.

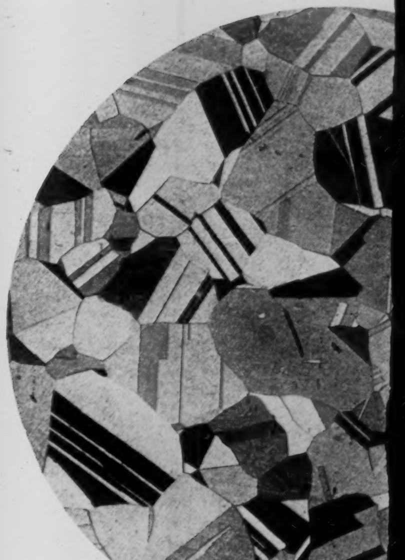




(*d*) 0.035 mm. average grain diameter.

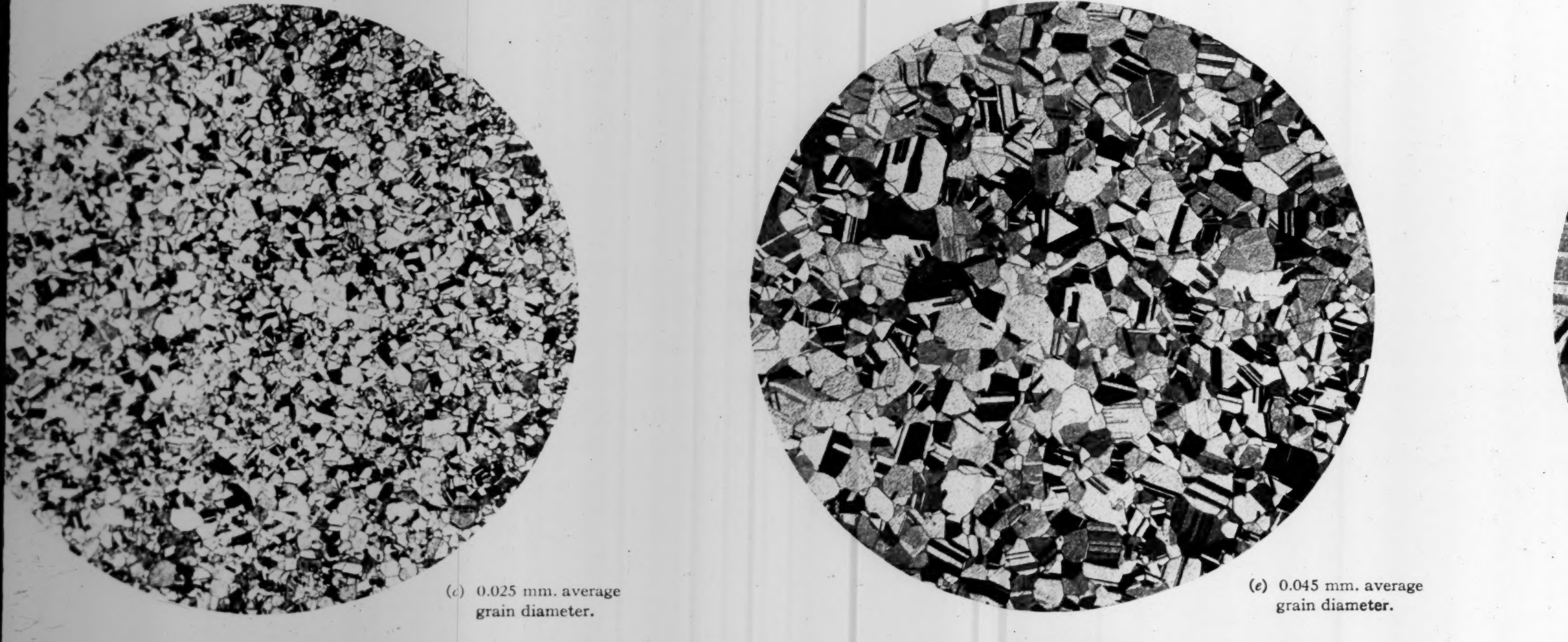


(*f*) 0.065 mm. average grain diameter.



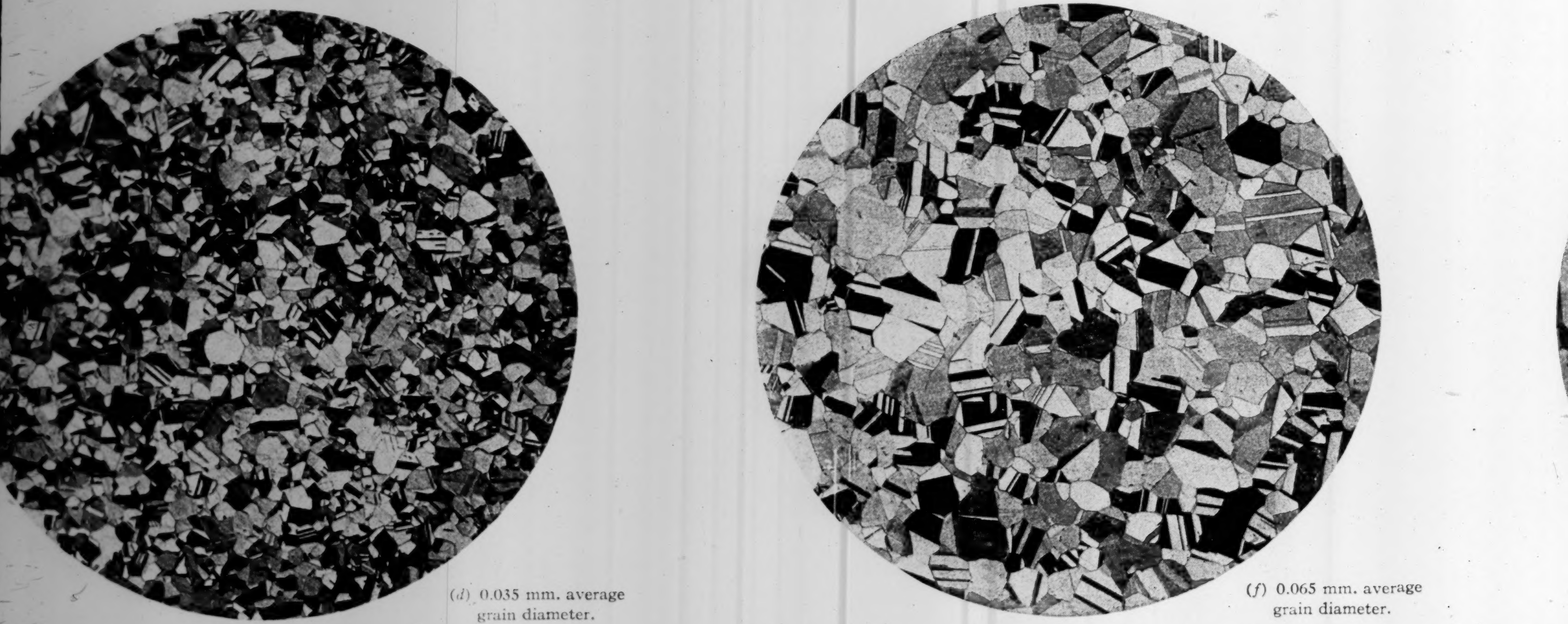
andards for the Estimation of the Diameter of Average Grain of Annealed Materials, Particularly Non-Ferrous Alloys Such as Brass, Bronze, and Nickel-Silver

The micrographs are of 70–30 copper-zinc alloy, etched by ammonia and hydrogen peroxide (× 75).



(c) 0.025 mm. average grain diameter.

(e) 0.045 mm. average grain diameter.



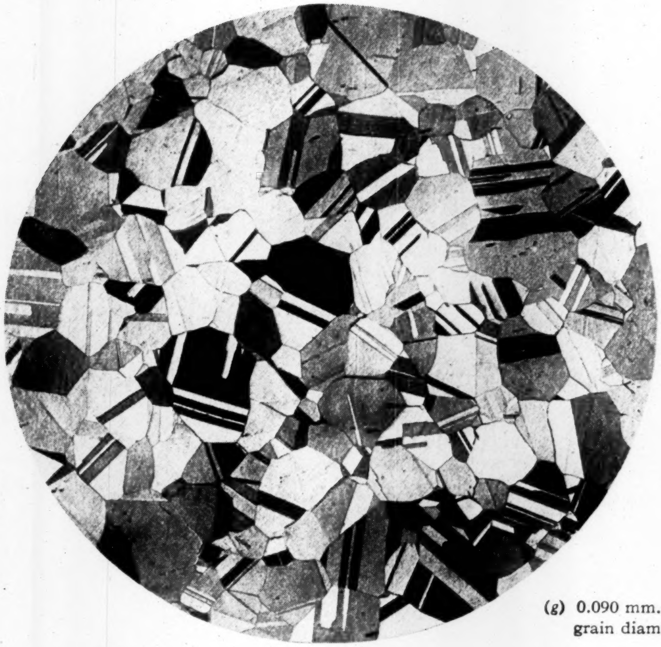
(d) 0.035 mm. average grain diameter.

(f) 0.065 mm. average grain diameter.

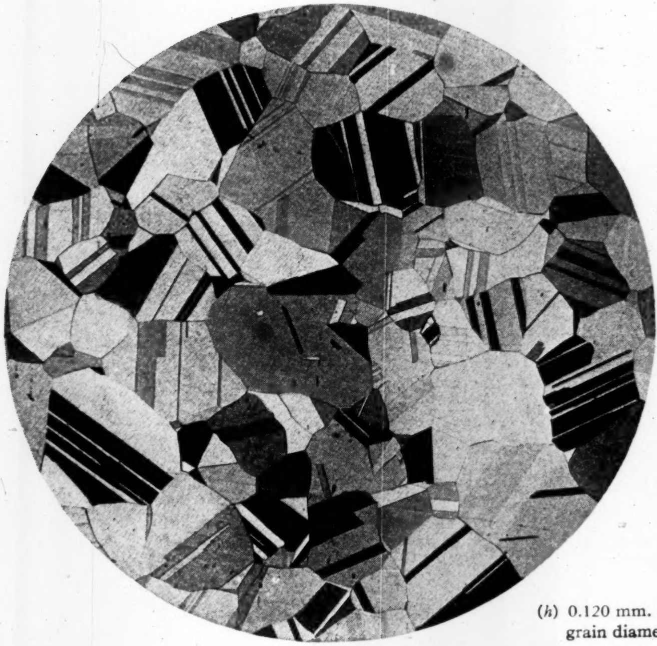
Fig. 1.—Grain Size Standards for the Estimation of the Diameter of Average Grain of Annealed Materials, Particularly Non-Ferrous Alloys Suc

The micrographs are of 70–30 copper-zinc alloy, etched by ammonia and hydrogen peroxide (× 75).

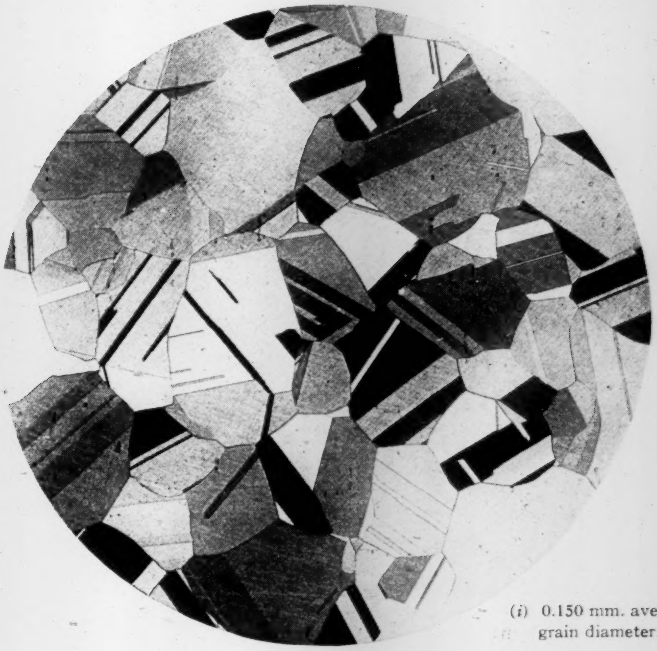
PLATE VII.
PROC. AM. SOC. TESTING MATS.
VOL. 29, PART I.
REPORT OF COMMITTEE E-4:
GRAIN SIZE STANDARDS.



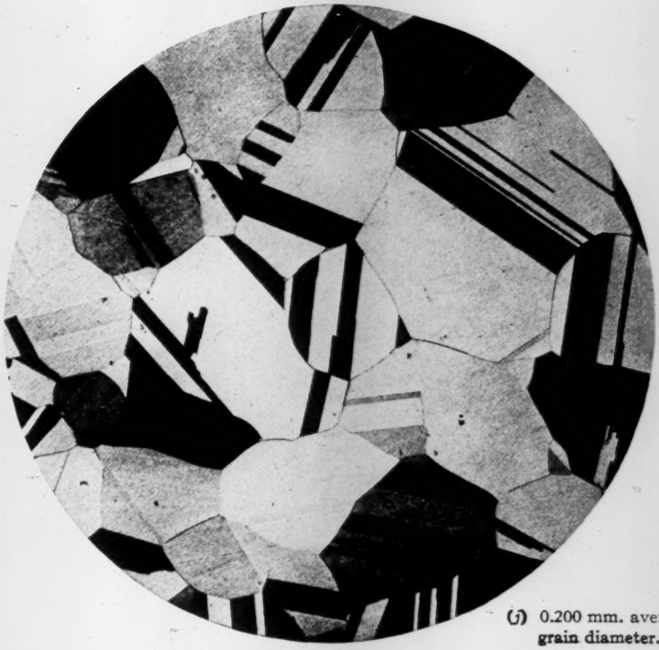
(g) 0.090 mm. average grain diameter.



(*h*) 0.120 mm. average grain diameter.



(*i*) 0.150 mm. average grain diameter.



(*j*) 0.200 mm. average grain diameter.

ys Such as Brass, Bronze, and Nickel-Silver.

REPORT OF COMMITTEE E-5

ON

STANDING COMMITTEES

During the year Committee E-5 on Standing Committees has held one meeting, on April 15, 1929, at the Society's headquarters, at which it considered several important matters referred to it by the Executive Committee of the Society. These related to:

1. The creation of a new standing committee of the Society to be designated Committee E-10 on Standards, to consist of five members appointed by the Executive Committee, to act in an advisory capacity to the Executive Committee in matters concerning the standardization work of the Society and to have certain duties and authority, subject to such restrictions as may be imposed from time to time by the Executive Committee.

2. The adoption of the policy whereby standing committees may present reports to the Executive Committee between annual meetings of the Society and proposed new standards or proposed amendments of existing tentative standards contained in such reports may be reviewed by the proposed new Committee on Standards and if found satisfactory may then be published as A.S.T.M. tentative standard.

3. A proposal that Committee E-5 be given authority in all matters relating to compliance by standing committees with provisions of the Regulations Governing Standing Committees and in matters of interpretation of the provisions of these Regulations.

The consideration given by the committee to the proposals of the Executive Committee has led to the adoption of certain modifications in the Regulations Governing Standing Committees, which in accordance with the specified procedure have been formally approved both by Committee E-5 and the Executive Committee. Since the principal modifications of the Regulations also involve an amendment of Article VI of the By-laws of the Society, dealing with "Procedure Governing the Adoption of Standards," the Executive Committee is recommending to the Society that the proposed amendment of Article VI[1] be duly adopted in the prescribed manner and that the revised Regulations Governing Standing Committees shall become effective upon approval of the amendment of the By-laws by letter ballot of the Society.

The detailed modifications of the Regulations Governing Standing Committees are appended to this report. They have been duly submitted to a letter ballot of Committee E-5, which has resulted in their adoption by a vote of 41 affirmative and none negative, with 3 not voting.

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[1] See p. 65.—Ed.

In the following paragraphs the various actions of the committee are presented with brief discussions of their significance.

A NEW COMMITTEE ON STANDARDS

The considerations that have led the Executive Committee to create a new Committee on Standards are fundamental and far-reaching in their relation to the policies and administration of the standardization work of the Society, and are discussed in the Annual Report of the Executive Committee. These considerations were carefully reviewed by Committee E-5 in responding to the request of the Executive Committee for study of the matter and the committee is of the opinion that the new Committee E-10 on Standards will occupy an important place in the administrative set-up of executive and advisory functions as they relate to the standardizing activities of the Society. This is particularly true with respect to (1) the development of A.S.T.M. standardization work to cover adequately the entire field of engineering materials and (2) the contacts of the Society and its committees with other bodies engaged in standardization of materials. It seems necessary, with the very substantial growth of standardization work in recent years, to create a committee of this kind having certain executive and administrative authority and acting in an advisory capacity to the Executive Committee. It is clearly understood that the new committee will not, itself, formulate standards; it will occupy towards the standardization work of the Society a position somewhat analogous to that of Committee E-9 on Correlation of Research towards the research work. The suggested function of the committee in reviewing proposed new standards offered between annual meetings is more appropriately touched upon in the next section of this report.

MODIFICATIONS OF REGULATIONS GOVERNING STANDING COMMITTEES

Expediting the Standardization Procedure:

The modifications in the Regulations Governing Standing Committees appended to this report are designed to accomplish principally two things:

1. The establishment of a normal procedure for standing committees to submit reports between annual meetings of the Society; and
2. The establishment of a procedure for expediting the publication as tentative of new standards that have been adopted in prescribed form by a standing committee.

While these two objectives have been inspired primarily by the desire to accelerate where possible the bringing out of proposed new standards, there are other advantages in the establishment of a somewhat more flexible procedure than at present for the submission of committee reports. It not infrequently happens that standing committees are in a position within a few months following an annual meeting of the Society to report either provisionally or finally upon some of the subjects with which they have been working, yet their reports cannot now be made for possibly eight or nine months. By permitting committees to present reports to the Executive Committee at any time, and preprinting such reports and distributing them to the members as soon as available, it will be possible to bring to the attention of members of the Society much more quickly than is at present possible a sizable proportion of the committee work of the Society. There are several specific advantages: First, the earlier distribution of reports of committee action will give greater opportunity for review and study of committee recommendations or the results of committee investigations. The fact that such material would not reach the members as a part of a considerable volume of reports and papers as at present will in itself result in opportunity for more deliberate and mature study. Second, the committees in turn will benefit by the opportunity afforded for this more deliberate study of their work, which it is felt should be reflected in a greater volume of constructive criticism and discussion. Third, the congestion of publication that now obtains in the two or three months immediately preceding the annual meeting will be relieved—a matter that is fast becoming one of practical necessity.

The consideration of this matter in Committee E-5 has brought out clearly the fact that such *ad interim* reports may contain proposed new standards, proposed revisions of existing standards or tentative standards, advance announcement of recommendations to be made at the next annual meeting, and progress or even final reports on investigative work upon which the committee is engaged. It is planned that all matters covered in such reports, as at present in all preprinted committee reports, shall come regularly before the annual meeting for consideration and, of course, be subject to correction and modification; and it is only with respect to proposed new standards and proposed revisions of existing tentative standards that definitive action in advance of the annual meeting is contemplated.

A study of the Society's standardization procedure from the point of view of accelerating it in desirable ways has shown rather clearly that there is one step in the procedure that can be expedited without sacrifice of any basic principle underlying our standardization work, namely, the acceptance of proposed new standards as tentative after they have been finally approved by a standing committee. There is often a "time lag" of considerable proportions between final action by a standing committee (which is sometimes taken and often can be taken six or more months before an annual meeting) and acceptance as tentative at the annual meeting—a delay that seems unnecessary and is likely to become a handicap to the Society in serving the standardization needs of industry. It is believed that this time interval can be greatly reduced without jeopardizing the safeguards that our procedure has placed around the establishment of an A.S.T.M. Standard. The acceptance as A.S.T.M. Tentative Standard of a specification or method of test that has been completely worked out and formally approved by letter ballot of a standing committee is more and more becoming a purely routine action by the Society assembled in annual meeting, for in the large majority of cases the work of the committees is so well and completely considered and gives such complete opportunity for all interests to be heard, that it is seldom that the Society refuses to publish for a year as tentative a proposed new standard thus offered to it.

The procedure outlined in the proposed new Section 15 (*b*) of the Regulations Governing Standing Committees[1] provides for a review of proposed new standards or proposed amendments of existing tentative standards by the new Committee E-10 on Standards, which must determine whether all requirements relating to the preparation and submission of new standards have been complied with and whether the standing committee has reached a substantial consensus in its recommendations. In this it is performing essentially the functions of a session of the annual meeting, with perhaps the added advantage of opportunity for more careful scrutiny of procedure and consideration of the merits of any moot points; it represents, in effect, the interest of the Society as a body in assuring itself of justification for publication as tentative of a new specification or method. The interests of the standing committee are protected by the privilege of representation on Committee E-10 during consideration of its recommendations. Dissenting members of the standing committee will have the same right to present minority reports when the majority report is considered that they now have. If the review is satisfactory to the Committee on Standards it may accept the proposed new standard or proposed amendments of existing tentative standards for publication as A.S.T.M. Tentative Standard. A tentative standard so promulgated between annual meetings is to be formally brought before the succeeding annual meeting, where it will be subject to amendment in the usual way and will normally be continued as tentative for another year.

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[1] See p. 519.—ED.

It is to be clearly emphasized that the proposed modifications do not in any way affect the methods now provided for fullest possible consideration of standards in committee, nor do they in any wise modify the procedure by which the Society formally adopts A.S.T.M. Standards and revisions thereof, namely, by action on appropriate committee recommendations at an annual meeting and subsequent reference to a letter ballot vote of the Society. The proposed new procedure recognizes an important distinction between *receiving and publishing* as tentative, which is essentially for the purpose of giving publicity to the proposed new standard and securing criticism and comments, and final *adoption* as standard by formal vote of the Society. All essential purposes of expediting the procedure are met, it is felt, by furnishing a means for more quickly promulgating *tentative* standards.

The adoption of this procedure will undoubtedly encourage the standing committees to complete sections of their work as rapidly as possible with the knowledge that proposed new standards can be offered at any time during the year. The discussions in Committee E-5 brought out that there is undoubtedly a tendency in the standing committees to postpone work on some matters until the few months preceding the annual meeting, since at present there is only the one time at which the committees' recommendations may be received. The new procedure, incidentally, will be a further incentive towards the planning of the new year's work in connection with the meetings of committees held during the annual meeting of the Society—a policy that Committee E-5 took occasion a year ago to commend to the consideration of the standing committees.

Interpretation and Enforcement of Regulations:

The Executive Committee has delegated to Committee E-5 authority in matters of interpretation of provisions of the Regulations Governing Standing Committees and in matters relating to compliance by standing committees with these provisions, with the understanding that in case of disagreement between Committee E-5 and a standing committee the latter shall have the right of appeal to the Executive Committee, whose decision shall be final. While such questions have only infrequently arisen, there has heretofore been no established procedure for handling them. A suitable explanatory statement is being included in the introduction to the Regulations, as noted in the Appendix to this report.

Committee E-5 has authorized the formation of a committee of five of its members to exercise its authority in these matters.

MISCELLANEOUS MATTERS

Conduct of Committee Work by Correspondence:

The possibility of handling committee work by correspondence was discussed by Committee E-5, notice being taken of the degree to which this method has been developed in committee work of the Manufacturers Standardization Society of the Valve and Fittings Industry. It was felt that for relatively small groups, as in sub-committees, or sections, there were many useful possibilities in the method, which conserves time and expense of traveling—a fact that has been demonstrated by several committees of the Society. It was suggested that a considerable amount of preliminary work in the development of standards might be thus handled with a minimum of meetings, and that such methods might stimulate interest in Society work in general on the part of men who are far removed from the center of activity and cannot very well take an active part in committee meetings.

The committee has asked the chairman to discuss this matter in a communication to the officers of committees and sub-committees, pointing out its advantages and limitations and outlining methods that may be followed without conflict with Society regulations.

Use of Milliliter (ml.) as Accepted Unit of Capacity:

Committee E-5 has authorized a change in the Regulations Governing the Form but not the Substance of Standards[1] to indicate that the "milliliter" (abbreviated *ml.*) is preferred over "*cc.*" as a unit of capacity, reserving the term "cubic centimeter" (to be abbreviated *cu. cm.*) as a unit of volume. At present both terms are recognized, without preference. The use of "*cc.*" as a unit of capacity is not exact, the liter being by definition the actual metric unit of capacity; and it seems desirable that the publications of the Society should be edited accordingly.

This report has been submitted to letter ballot vote of the committee, which consists of 44 members; 42 members returned their ballots, of whom 41 have voted affirmatively, and none negatively, and 1 has marked his ballot "not voting."

Respectfully submitted on behalf of the committee,

C. L. WARWICK,
Chairman.

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[1] 1928 A.S.T.M. Year Book, p. 267.—ED.

APPENDIX

REVISIONS IN THE REGULATIONS GOVERNING STANDING COMMITTEES[1]

(APPROVED JOINTLY BY THE EXECUTIVE COMMITTEE AND COMMITTEE E-5 ON STANDING COMMITTEES)

The revisions that have been made in the Regulations Governing Standing Committees are given in detail below. The revision in Section 15, which is a quotation of Article VI, Section 1, of the By-laws, is dependent upon approval of the required amendment of that section of the By-laws by the Society. Words in italics have been inserted; words in brackets have been deleted.

Add the following paragraph to the introduction to the Regulations:

> *The Executive Committee has delegated to Committee E-5 on Standing Committees authority in matters of interpretation of the provisions of these Regulations and in matters relating to compliance by standing committees with these provisions. In the case of disagreement between Committee E-5 and a standing committee, the latter shall have the right of appeal to the Executive Committee, whose decision shall be final.*

Change the last sentence of Section 14 on "Preparation of Standards" to read as follows:

> Dissenting members shall have the right to present minority reports, individually or jointly, at the [annual meeting of the Society] *time* at which the majority report is presented *and considered.*

Change Section 15 on "Procedure Governing the Adoption of Standards" to read as follows:

> **15. Procedure Governing the Adoption of Standards.**—[Any recommendations affecting standards presented by the appropriate committees at the annual meeting of the Society shall be subject to the following provisions in Article VI, Section 1, of the By-laws.] *Acceptance of proposed new standards for publication as tentative standard or acceptance of proposed modifications of existing tentative standards shall be either by action of the Society in annual meeting or by review of the Committee on Standards as provided in Paragraphs* (*a*) *and* (*b*). *All other actions upon recommendations affecting standards and tentative standards shall be taken only at the annual meetings of the Society. The following procedures are quoted from Article VI, Section 1, of the By-laws:*

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[1] The Regulations in their present form appear in the 1928 A.S.T.M. Year Book, pp. 243–252.

"(*a*) Proposed new standards, *except as provided in Paragraph* (*b*), shall be presented at an annual meeting, at which they may be amended by a two-thirds vote of those voting. On two-thirds vote of those voting, they shall be printed, as presented or as amended, in the Proceedings and separately under the title "Tentative Standards," on which written discussions addressed to the appropriate committee shall be invited. At the next annual meeting tentative standards shall be subject to amendment by a two-thirds vote of those voting. They may then be referred, by a like vote, to letter ballot of the Society in which case a two-thirds vote of those voting shall be required for adoption; or, on the recommendation of the committee concerned, they may be continued as tentative, as printed or as amended, in which case the above prescribed procedures shall apply at any succeeding annual meeting.

"(*b*) *Proposed new standards or proposed amendments of existing tentative standards may also be presented between annual meetings, in which case they shall be reviewed by the Committee on Standards, which shall determine whether all requirements relating to the preparation and submission of standards have been complied with and whether the standing committee has reached a substantial consensus in its recommendations to the Society. If such review is satisfactory to the Committee on Standards, it may accept the proposed new standards or proposed amendmends of existing tentative standards for publication as tentative standard. During consideration of and action upon the recommendations of a standing committee, two designated representatives of the standing committee shall serve as members of the Committee on Standards, with full privileges of discussion and vote. At the annual meeting following the publication of a tentative standard or amendment under this procedure the standing committee concerned shall report the acceptance of the tentative standard or amendment, which shall be subject to amendment at that annual meeting by a two-thirds vote of those voting. Tentative standards reported at an annual meeting for the first time shall normally be continued as tentative.*"

Add the designating paragraph letter (*c*) to the third paragraph of the present Section 15.

Add the designating paragraph letter (*d*) to the fourth paragraph of the present Section 15.

"(*e*) The [above requirement] *requirements in Paragraphs* (*a*), (*b*) *and* (*c*) by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or more years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above prescribed vote as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected."

Add the designating paragraph letter (*f*) to the sixth paragraph of the present Section 15.

Change the title of Section 17 from "Reports" to "Reports at Annual Meetings."

Add a new Section 18 reading as follows:

18. Reports Between Annual Meetings.—*Between annual meetings, committees may present reports to the Executive Committee. Reports containing proposed new standards or proposed amendments of existing tentative standards* *shall be reviewed by the Committee on Standards as provided in Section 15 (b), and shall conform to the requirements of Sections 14 and 17 that are applicable.*

In such reports between annual meetings a standing committee may include for information other recommendations affecting standards and tentative standards that it will make formally at the next annual meeting.

Renumber all sections after present Section 17.

Add the following paragraph to the present Section 18 (new Section 19):

Reports received between annual meetings shall be mailed by the Secretary-Treasurer to every member of the Society who has signified his desire to receive such reports.

REPORT OF COMMITTEE E-6
ON
PAPERS AND PUBLICATIONS

Since the last annual meeting the Committee on Papers and Publications has held its usual two meetings, one on December 10, 1928, at which preliminary plans for the program of this annual meeting were considered and certain routine business transacted; and the other on February 27, 1929, at which all offers of papers were passed upon for acceptance and the main features of the program determined.

As this report is written, the program of the annual meeting has been in the hands of the members for some eight weeks. It contains two important symposiums, one on the Physical Properties of Cast Iron and the other on Mineral Aggregates. The latter is of such magnitude as to require two sessions; and the total volume of reports and papers is such as to require the holding of the meeting in fifteen sessions, one more than the preceding year.

An unusually strong feature of the program is the number of reports and papers dealing with the non-ferrous metals and alloys, to which two sessions are devoted; another session includes reports and papers on corrosion and fatigue of metals, an interesting feature of which is two discussions of interpretation of the Society's corrosion test data. Another session is devoted to subjects of nomenclature, research and methods of testing, and in addition to reports on those subjects contains papers discussing proportional limit in metals, tests of reinforcement bars and testing of mineral products. The session on cement and concrete contains a number of interesting contributions to knowledge in this field. Several papers on the program have developed more or less directly from committee activities, among them being papers on reduction from steel ingot to forging, on life tests of electrical heating materials, on die-casting alloys, on fire tests of timber, on repeated compression of rubber compounds, on effect of storage on properties of turpentine, and on plastic flow. With respect to the number of items on the program, this is probably the largest in the history of the Society. There are 50 committee reports, including several from joint committees and sectional committees functioning under A.S.A. procedure; and 59 technical papers including the Annual Address of the President and the Edgar Marburg Lecture, making a total of 109 items.

Of these all but five reports and four papers (the latter including the Marburg Lecture) have been preprinted. For the most part the five reports not preprinted are very brief and in the nature of progress reports. Three papers were received too late to be preprinted. The Marburg Lecture will as usual be reprinted and mailed to all members who have requested copies.

While the number of committee reports for this year is as great as ever, the volume is somewhat less than for last year. This is to some extent balanced by the greater number and volume of technical papers. Comparative data for this year and the two preceding years follow:

	1927	1928	1929
REPORTS:			
Total Number	49	48	50
Number Preprinted	46	44	45
Pages Preprinted	887	801	593
PAPERS:			
Total Number	32	47	59
Number Preprinted	31	38	55
Pages Preprinted	373	545	643
TOTAL REPORTS AND PAPERS:			
Total Number	81	95	109
Number Preprinted	77	79	100
Pages Preprinted	1260	1346	1236

The five reports and four papers not yet preprinted occupy respectively 10 and 121 pages, bringing the total number of pages of reports and papers on the program to 1367, which compares with 1546 for last year.

The publication of the Index to Standards and Tentative Standards is an important publication development during the year. In issuing the 1928 Supplement to the 1927 Book of A.S.T.M. Standards a sheet of stickers was issued to each member to be used in indicating in the Book of Standards those standards that had been superseded or withdrawn, appropriate notice having been printed on all standards in the supplement replacing those in the 1927 edition. This plan will be followed this year in issuing the 1929 supplement.

Several committees of the Society continued their plan of arranging for the annual publication in separate pamphlet form of their reports and the standards and tentative standards that they have prepared. The publication of these reprints is particularly useful to the members of the committees and it serves to disseminate the committee's work conveniently among the industries interested. The policy is one that is receiving the official encouragement of this committee.

The committee has added a provision to the Regulations Governing Presentation of Discussions to the effect that written discussion of a length requiring more than five minutes for presentation shall be accompanied by an abstract and at the discretion of the chair shall be presented in abstract only. It is intended to take advantage of this requirement only in those cases where the volume of written discussion is so great that there is not time for presentation of all discussion in full.

The committee is prepared to arrange during annual meetings of the Society for so-called "round table" discussion upon the recommendation of any committee that desires to arrange for special discussion of some subjects, whether presented on the program of the meeting or otherwise. One such discussion was held very successfully at the annual meeting a year ago and the plan has proved successful in meetings of other technical societies where it has been tried.

The following papers have been reported to the Papers Committee as having been presented at committee meetings during the year:

Committee D-13 Meeting, October 10–11, 1928:

"A Multiple-Strand Test for Yarns," by C. W. Schoffstall and H. A. Hamm;

"Research Work in Quality and Utilization of Cotton," by Dr. B. Youngblood;

"Measurement of the Thickness of Fabrics," by W. E. Emley;

"New Developments in Testing Machines," by David C. Scott;

"Measurement of Permeability of Fabrics in Air," by W. E. Emley.

Committee D-16 Meeting, January 17, 1929:

"Some Remarks on Recent Progress with the Wire Saw," by Oliver Bowles;

"Hydraulic Stripping," by E. S. Harter.

Respectfully submitted on behalf of the committee,

C. L. WARWICK,
Chairman.

REPORT OF COMMITTEE E-8
ON
NOMENCLATURE AND DEFINITIONS

This report, as were previous reports of Committee E-8, is largely a statement of the present status of the definitions of terms accepted for publication at the last annual meeting and the definitions that have been reviewed and approved by Committee E-8. As is evident from the report, considerable progress is being made toward the final approval of all definitions of the Society. In all, Committee E-8 has now approved 263 definitions as standard. It still has 117 tentative definitions before it for review and in addition there are 213 standard definitions that have not received the review and approval of the committee. Five definitions are being approved by Committee E-8 this year. With these, Committee E-8 will have approved 268 definitions of terms. The definitions continued as tentative and those being recommended for adoption are discussed below in greater detail and the work of the several sub-committees discussed.

Two new sub-committees have been organized during the year to consider tentative definitions now before the committee, namely, a Committee on Definitions of Terms Relating to Petroleum Products, under the chairmanship of K. G. Mackenzie, to take under consideration definitions submitted at the last annual meeting by Committee D-2 on Petroleum Products and Lubricants, and a Committee on Definition for the Term Brick, under the chairmanship of H. P. Tiemann, to consider the definition for this term published as information in the 1928 Report of Committee E-8 and to develop a definition for the approval of the standing committees concerned.

The Sub-Committees on Sieve and Screen, on Sand and Aggregate and on Concrete have lost their chairman, Mr. L. R. Ferguson, through resignation. A new chairman of these three sub-committees is still to be appointed.

Much of the review work, as in the past, has been handled by the Editorial Committee of the Advisory Committee. This committee has considered during the past year a number of the definitions, both in the tentative and sub-tentative status and has discussed these with the standing committees having jurisdiction over the definitions in question. Since much of the work is handled by correspondence only one meeting was found necessary during the year, a meeting of the Advisory Committee held on May 23.

Acting on the suggestions of the Editorial Committee, definitions in the sub-tentative status have been modified by the standing committees having jurisdiction over them and are being submitted at this annual meeting for publication as tentative. As previously mentioned, this plan of having definitions reviewed before submission to the Society expedites their final approval by Committee E-8, since very little further consideration is necessary before the definitions can receive the formal approval of the committee and be advanced to standard. It is for this reason that Committee E-8 encourages the development of definitions under this procedure and invites the standing committees to consult with Committee E-8 in the preparation of definitions.

The committee has also had under consideration during the year the adoption of a standard form of note to be applied in the case of certain types of definitions. Two forms of notes are recognized, one applying to definitions of basic materials where there is one generally accepted use of the term but where the definition also applies to substitute materials; the second applying to definitions of products of manufacturing processes.

In the case of products of manufacturing processes a term might have a generally accepted meaning as applying to one specific product but also be used in connection with other products. Since a manufacturing process is involved it might well be that changes would come about that would cause the term to no longer have one generally accepted meaning. For this reason the note should read "in the present state of the art." The committee has under consideration the adoption of the following wordings for these two types of notes:

For the form of note applying to basic materials:

When used without a qualifying adjective, the term .... is generally understood to mean ....

For the form of note applying to products of manufacturing processes:

In the present state of the art the term ...., when used without a qualifying adjective, should be understood to mean ....:

In respect to the note applying to the products of manufacturing processes, the suggested form differs from that now in use in that it specifically distinguishes this form of note from that used for basic materials by using the expression "should be understood to mean," indicating a definite usage that should apply, whereas the first form of note uses the expression "is generally understood to mean" indicating a statement of fact of current usage. The two forms of note indicated above are published herewith as information and the committee would appreciate receiving any comments in respect to their ultimate adoption.

Glossary of Terms.—The Glossary of all definitions of terms appearing in the standards and tentative standards of the Society, mentioned in the 1928 Report of Committee E-8 as being in preparation, was issued during the year in mimeographed form and was brought to the attention of all members of Committee E-8 and the officers of standing committees. It has further received wide distribution as a result of an announcement appearing in the A.S.T.M. Bulletin that copies were available to all those interested.

A number of criticisms were received from the members of Committee E-8 and were transmitted to the committees concerned. In view of these criticisms some modifications of the present definitions are being made and certain other changes in arrangement will be made in the Glossary. The Glossary will again be issued in mimeographed form, containing all revisions resulting from actions taken at the annual meeting and the revised Glossary will be brought specifically to the attention of the standing committees with the request that these committees give it a careful review to determine if any of the definitions contained therein, but under the jurisdiction of other standing committees, are of interest to that committee and, if so, whether they are satisfactory in their present form. That is, each standing committee should consider if the individual definitions may have some application to the work of that standing committee, and if so whether the wording of the definition as given at present is entirely adequate.

In preparing new definitions, standing committees should of course consult the Glossary to see if any existing definitions are applicable.

Definitions of Terms Approved by Committee E-8

As a matter of record, a complete list of the 263 terms approved by Committee E-8 is included, as given below:

Absolute Specific Gravity (of solids and liquids)
Accelerator
Aging Coefficient
Alberts
Alloy
Alpha Brass
A.S.T.M. Paraffin Wax Melting Point
A.S.T.M. Petrolatum Melting Point
A.S.T.M. Precipitation Number of Lubricating Oils
Apparent Specific Gravity (of solids)
Army Duck
Ash
Asphalt Mastic
Asphalt Mastic Cake

Baggy Fabric
Balata Belt Duck
Beta Brass
Binder
Bituminous Grout
Book Tile
Bulk Specific Gravity (of solids)
Calcined Gypsum
Cells
Cement
Clay
Clay (in the case of textiles)
Clay Separate
Cloud Point
Coercive Force
Cord
Core Loss
Corkscrew Twist
Correction
Count
Crimp
Crushed Gypsum
Defective Splice
Diaspore Clay
Drills
Drying Oil
Enamel
Enameling Duck
End-Construction Tile
Ends
Equi-axed Grain
Error
Etching Reagent
Filler
Fire Clay
Fixed Carbon
Flint Fire Clay
Float
Foundation Tile
Furring Tile
Grain
Grain Size
Gypsum
Gypsum Molding Plaster
Gypsum Plastering Sand
Gypsum Pottery Plaster
Hollow Floor Tile
Hollow Tile
Hollow Tile Fireproofing
Hose Duck
Hydrated Lime
Imperfect Selvage
Irregular Pick
Jeans
Keene's Cement
Kink
Knot
Lake
Lath
Lea
Length
Load Bearing Wall Tile
Loading Range
Lump Lime
Lump Lime Screened
Macrograph
Magnetic Permeability
Magnification
Mechanical Fabric
Metal
Metallography
Micrograph
Mispick or Broken Pick
Missing Warp (Yarn or Cord)
Moisture
Moisture Content (Moisture, Percentage of Moisture) (in the case of textiles)
Mortar
Nodular Fire Clay
Non-Drying Oil
Normal Induction
Numbered Duck
Off-Square
Oil Belt Duck
Organic Acetone Extract
Partition Tile
Percentage of Error
Picks
Plain Weave
Plaster
Plastic or Bond Fire Clay
Porous Hollow Tile
Pour Point
Proximate Analysis
Pucker (Puff or Blister)
Pulverized Lime
Quicklime
Reed Mark
Residual Induction
Retarder

Rubber Belt Duck
Salt-Glazed Tile
Sand
Saponifiable Acetone Extract
Scoring
Semi-Drying Oil
Serge
Sewed Yarn
Shale
Shell
Side-Construction Tile
Single Filled or Flat Duck
Size
Sized Gypsum
Slack and Tight Warp or Filling Yarns or Cords
Slate
Slug
Smash
Specific Gravity (of solids and liquids)
Split or Chafed Yarn or Cord
Split Tile
Standard Atmosphere
Standard Condition
Standard Core Loss
Standard Regain
Standard Weight
Stucco
Surface Clay
Testing Machine
Thick and Thin Places (Major Defects)
Thick and thin Places (Minor Defects)
Thickness
Thread
Tire Builder Fabric
Tire Cord Fabric
Tolerance
Toner
Total Waxy Hydrocarbons
Twill
Twist, Direction of
Twist, Direction of (Sewing Thread)
Ultimate Analysis
Unsaponifiable Resins
Varnish
Volatile Matter
Webs
Width
Wood Fiber
Wrong Draw
Yarn

In addition to the 150 terms listed in the report of the committee for 1928, the above list includes 16 additional terms adopted at the 1928 annual meeting, and omits three withdrawn.

TENTATIVE DEFINITIONS BEFORE COMMITTEE E-8

As mentioned above, 16 tentative definitions were adopted as standard at the 1928 annual meeting. Fifty-four new tentative definitions were submitted as follows:

Definitions Relating to Petroleum Products:

Crude Petroleum
Topped Crude Petroleum
Weathered Crude Petroleum
Benzine
Petroleum Naphtha
Gasoline
Petroleum Spirits (White Spirits)
Kerosine
Gas Oil
Fuel Oil
Tar, Pitch
Petroleum Lubricating Grease
Oil-Shale
Crude Shale Oil
End Point
Engine Distillate
Tops
Specific Gravity (of petroleum oil)
A.P.I. Gravity

Definitions Relating to Rubber Products:

Acetone Extract
Chloroform Extract
Alcoholic-Potash Extract
Free Sulfur
Total Sulfur
Ash
Sulfur in Ash
Total Compounding Ingredients

Definitions Relating to Textile Materials:

Breaker Tire Fabric
Sheeting
Osnaburg
Airplane Fabric (Cotton)
Awning Cloth
Tent Duck
Webbing, Elastic
Dungaree
Burlap
Felt
Cockled
Broken Ends
Broken Picks
Hawser Twist
Cable Twist
Hard Twist
Twine
Rope
Laid Fabric
Holland
Book-Fold
Shoe-Fold
Asbestos Yarn
Plain Asbestos Yarn
Metallic Asbestos Yarn
Cut
Ply

Twenty-two definitions were withdrawn, incorporated with other definitions, or classed by Committee E-8 as not definitions, as follows:

In Bulk (C 51)
Bad Start-up (D 122; D 123)
Chafed Cord (D 179)
Missing Cord (D 179)
Contractor (D 290 T)
Engineer (D 290 T)
Laboratory (D 290 T)
Plant Laboratory (D 290 T)
Concrete Brick (C 55 T)
Average Sample (D 270 T)
All-Levels Sample (D 270 T)
Upper Sample (D 270 T)
Middle Sample (D 270 T)
Lower Sample (D 270 T)
Composite Sample (D 270 T)
Continuous Sample (D 270 T)
Dipper Sample (D 270 T)
Mixed Sample (D 270 T)
Thief Sample (D 270 T)
Drain Sample (D 270 T)
Bottom Sample (D 270 T)
Borings Sample (D 270 T)
Grab Sample (D 270 T)

This left 117 tentative definitions before Committee E-8 for consideration. Grouped below according to subject matter, the present status of these definitions is indicated.

Terms Relating to Heat Treatment Operations (A 119).—The 14 terms defined by Committee A-4 on Heat Treatment of Iron and Steel are as follows:

Heat Treatment
Quenching
Hardening
Annealing
Normalizing
Spheroidizing
Tempering
Malleablizing
Graphitizing
Carburizing (Cementation)
Case Hardening
Case
Core
Cyaniding

These definitions are still under consideration in Committee E-8. No comments or suggestions have as yet been forwarded to Committee A-4, but it is planned to discuss these definitions with that committee in some detail during the coming year.

Term Relating to Lime (C 25).—One term defined by Committee C-7 on Lime is still continued as tentative, the definition for the term "available lime." Suggestions for the definition of this term have been transmitted to Committee C-7 but, since the methods in which it appears are not being recommended for advancement to standard, no action is being taken on this definition by Committee E-8 at the present time.

Terms Relating to Refractories (C 71).—Two terms defined by Committee C-8 on Refractories are continued as tentative as follows:

Spalling
Pyrometric Cone Equivalent (P.C.E.)

Comments in respect to these two definitions were forwarded to Committee C-8 and the definitions are being given further consideration in that committee.

Terms Relating to Gypsum.—Five terms defined by Committee C-11 on Gypsum, still continued as tentative are as follows:

Aggregate (C 11)
Consistency (C 11)
Gypsum Plaster Board (C 11, C 37)
Gypsum Wall Board (C 11, C 36)
Plasticity (C 11)

Definitions for "consistency" and "plasticity" have been under consideration in a Technical Committee, of Committee E-1 on Methods of Testing, on Consistency, Plasticity, etc. As a result of discussions in that committee, Committee C-11 is this year recommending revisions of these two definitions. The definition for the term "aggregate" is still under consideration in a sub-committee of Committee E-8. Committee C-11 is proposing to advance to standard the definitions for "gypsum wall board" and "gypsum plaster board." The definitions are not satisfactory to Committee E-8 in their present form, however, and that committee has accordingly not approved the advancement to standard of these definitions.

Terms Relating to Paint (D 16, D 266).—Four tentative definitions prepared by Committee D-1 on Preservative Coatings for Structural Materials are as follows:

Toughness
Elasticity
Screen (Sieve)
Leafing

Committee D-1 is contemplating the preparation of additional definitions of terms relating to paint materials and a general review of its present standard definitions. The several definitions listed above will be given further consideration in this more general work on definitions now taking place.

Terms Relating to Petroleum Products.—The following 22 terms appear in the methods of test and definitions prepared by Committee D-2 on Petroleum Products and Lubricants:

Alkali Neutralization Number (D 188)
Mineral Acid Neutralization Number (D 188)
Neutralization Number (D 188)
Crude Petroleum (D 288)
Topped Crude Petroleum (D 288)
Weathered Crude Petroleum (D 288)
Benzine (D 288)
Petroleum Naphtha (D 288)
Gasoline (D 288)
Petroleum Spirits (White Spirits) (D 288)
Kerosine (D 288)
Gas Oil (D 288)
Fuel Oil (D 288)
Tar, Pitch (D 288)
Petroleum Lubricating Grease (D 288)
Oil-Shale (D 288)
Crude Shale Oil (D 288)
End Point (D 288)
Engine Distillate (D 288)
Tops (D 288)
Specific Gravity (of Lubricating Oil) (D 287)
A.P.I. Gravity (D 287)

The definitions of terms submitted last year by Committee D-2 appearing in the Tentative Definitions of Terms Relating to Petroleum (D 288) are being considered by a newly organized Sub-Committee on Definitions of Terms Relating to Petroleum Products. The three definitions appearing in the Tentative Method of Test for Neutralization Number of Petroleum Products and Lubricants (D 188) are still under discussion with Committee D-2. The two definitions appearing in the Tentative Method of Test for Gravity of Petroleum and Petroleum Products by Means of the Hydrometer (D 287) will be taken under consideration in Committee E-8 during the coming year.

Terms Relating to Coal and Coke (D 121).—Five terms defined by Committee D-5 on Coal and Coke and continued as tentative are as follows:

Coke
Beehive Coke
By-Product Coke
Coke Breeze
Dry Coke

Revisions of these definitions of terms are under consideration in Committee D-5 on Coal and Coke and that committee proposes to submit new definitions during the coming year.

Terms Relating to Insulating Materials (D 150, D 257, D 115).—The 9 terms defined by Committee D-9 on Electrical Insulating Materials are as follows:

Power Factor
Dielectric Constant
Loss Factor
Insulation Resistance
Volume Resistance
Surface Resistance
Volume Resistivity
Surface Resistivity
Absolute Viscosity

These definitions, with the exception of the definition for "absolute viscosity," are satisfactory to Committee E-8 in their present form. They are not, however, being recommended for advancement to standard this year and no action on their approval has been taken by Committee E-8. The definition for "absolute viscosity" will be reviewed in the light of the consideration now being given to terms of a similar nature in the Technical Committee, of Committee E-1, on Consistency, Plasticity, Etc.

Terms Relating to Rubber Products (*D 297*).—The 8 definitions submitted last year by Committee D-11 on Rubber Products are as follows:

Acetone Extract
Chloroform Extract
Alcoholic-Potash Extract
Free Sulfur
Total Sulfur
Ash
Sulfur in Ash
Total Compounding Ingredients

These terms are under consideration in Committee E-8.

Terms Relating to Textiles (*D 123, D 258, D 299*).—The 37 terms defined by Committee D-13 on Textile Materials are as follows:

Loop Knot
Gage
Regain (Moisture Regain)
Rayon
Rayon Yarns
Spun Rayon
Nitro-Cellulose Rayon (Chardonnet)
Viscose Rayon
Cuprammonium Rayon
Cellulose-Acetate Rayon
Asbestos Yarn
Plain Asbestos Yarn
Metallic Asbestos Yarn
Cut
Ply
Breaker Tire Fabric
Sheeting
Osnaburg
Airplane Fabric (Cotton)
Awning Cloth
Tent Duck
Webbing, Elastic
Dungaree
Burlap
Felt
Cockled
Broken Ends
Broken Picks
Hawser Twist
Cable Twist
Hard Twist
Twine
Rope
Laid Fabric
Holland
Book-Fold
Shoe-Fold

Of these definitions, the definitions for "asbestos yarn," "plain asbestos yarn," "metallic asbestos yarn," "cut" and "ply" are being recommended by Committee D-13 for advancement to standard this year. They have received the review of Committee E-8 and, with certain modifications which are acceptable to Committee D-13, have been approved by Committee E-8.

The remaining definitions have been reviewed by Committee E-8 and suggestions transmitted to Committee D-13, which are receiving the attention of that committee.

Terms Relating to Methods of Testing.—Definitions for the following 8 terms, prepared by Committee E-1 on Methods of Testing, appear in the Tentative Definitions of Terms Relating to Methods of Testing (E 6), in the Tentative Methods of Compression Testing of Metallic Materials (E 9), and in the Tentative Methods of Tension Testing of Metallic Materials (E 8):

Stress
Strain
Stress-Strain Diagram
Elastic Limit
Yield Point
Tensile Strength
Compressive Strength
Modulus of Elasticity

With the exception of the definitions for "elastic limit" and "yield point," agreement has been reached between Committee E-8 and Committee E-1 in respect to the wording of these definitions and it is expected that they will be advanced to standard during the coming year. The definitions for "elastic limit" and "yield point" are receiving further consideration in Committee E-1.

Miscellaneous Terms.—There are 2 terms classed as miscellaneous:

Aggregate (C 58)
Screen (Sieve) (E 13)

These definitions are under the jurisdiction of Committee E-8 and are being continued as tentative by that committee.

ACTIVITIES OF SUB-COMMITTEES

Sub-Committee on Definitions of the Terms Sieve and Screen.—The chairman of this sub-committee, L. R. Ferguson, has resigned and as yet no new chairman has been appointed. Accordingly there is no further progress to be reported on behalf of this sub-committee. The definition for "screen (sieve)" developed by the sub-committee was recommended for advancement to standard at the 1928 meeting but, on the representations of Committee D-4 on Road and Paving Materials that it be given an opportunity to consider the withdrawal of its own definitions for "sieve" and "screen," the definition was continued as tentative in its present form: namely,

> *Screen (Sieve).*—A plate or sheet or a woven cloth, or other device, with regularly spaced apertures of uniform size, mounted in a suitable frame or holder, for use in separating material according to size.
>
> NOTE 1.—The shape and spacing of apertures, size of wires or threads, thickness of plate or sheet, allowable variations and similar properties should be taken care of in specifications.

NOTE 2.—In mechanical analysis testing work, when not otherwise specified, the term "sieve" shall apply to an apparatus in which the apertures are rectangular, and the term "screen" shall apply to an apparatus in which the apertures are circular.

Sub-Committee on Definitions of the Terms Sand and Aggregate.—Due to the resignation of the chairman of this sub-committee, L. R. Ferguson, the sub-committee has been without a chairman during the past year and accordingly there are no further developments to be reported on behalf of the sub-committee. The definition for the term "sand" prepared by this sub-committee was adopted as standard at the last annual meeting. The definition for the term "aggregate" developed by the sub-committee was recommended for advancement to standard at the 1928 meeting but on the representations of Committee D-4 on Road and Paving Materials that it be given an opportunity to consider the withdrawal of its own definition for "aggregate," the definition was continued as tentative as follows:

Aggregate.—In the case of materials of construction, designated inert material, which when bound together into a conglomerated mass by a matrix forms concretes, mastic, mortar, plaster, etc.

Sub-Committee on Definition of the Term Concrete.—The Sub-Committee on Concrete was also under the chairmanship of L. R. Ferguson and he resigned as the chairman of this sub-committee as well, so that this sub-committee has also been without a chairman. In the 1928 Report of Committee E-8 the sub-committee offered a proposed wording of the definition of "concrete" reading as follows:

Concrete.—A mixture of aggregate or aggregates and a binding medium which solidifies into a conglomerate mass.

NOTE.—In the present state of the art, the term concrete, when used without a qualifying adjective, is understood to mean portland-cement concrete.

Committee D-4 on Road and Paving Materials proposed an alternative note to the definition for "concrete" reading as follows:

NOTE.—The term concrete without descriptive adjective is indefinite and unspecific and should be always used with a qualifying adjective, indicating the cementing material which is present, that is, "asphaltic concrete," "coal-tar concrete," "portland-cement concrete," etc.

The definition is again published as information, with the two alternative notes, in order to elicit comments and suggestions for the benefit of the sub-committee in giving consideration to the development of a satisfactory definition.

Sub-Committee on Definition of the Term Brick.—A sub-committee was organized during the year under the chairmanship of H. P. Tiemann, to give consideration to the development of a definition for the term "brick." The definition published as information in the 1928 Report of Committee E-8, as given below, has been referred to that sub-committee for its consideration:

> *Brick.*—A material of construction in small regular units, solid or practically so, formed from inorganic substances and hardened in a shape approximating a rectangular prism.
>
> NOTE.—In the present state of the art, the term brick, when used without a qualifying adjective, is understood to mean a unit of burned clay or shale. When other substances are used the term brick should be suitably qualified. In the United States, building brick are usually 8 by $3\frac{3}{4}$ by $2\frac{1}{4}$ in. in size.

Sub-Committee on Terms Relating to Petroleum Products and Lubricants.—A new sub-committee was organized during the year, under the chairmanship of K. G. Mackenzie, to give consideration to the approval of the definitions of terms relating to petroleum products submitted as tentative by Committee D-2 on Petroleum Products and Lubricants at the 1928 annual meeting. This sub-committee has under consideration suggestions in respect to these definitions submitted by the Editorial Committee. The sub-committes has also before it the consideration of definitions of the terms "bitumen," "asphalt," "tar" and "pitch," approved by a committee of the International Roads Congress which have been under discussion with the British Engineering Standards Association, Mr. Prévost Hubbard, the secretary of Committee D-4 on Road and Paving Materials, serving as the Society's representative. It is expected that a report on proposed modifications of A.S.T.M. definitions of certain terms involved in this international discussion will be reported at this annual meeting.

DEFINITIONS OF TERMS IN PREPARATION REFERRED TO COMMITTEE E-8

Definitions of Terms Relating to Magnetic Testing.—Committee A-6 on Magnetic Properties published a list of terms as information with its 1928 report. These were submitted during the past year to Committee E-8 for consideration. The Editorial Committee of Committee E-8 has reviewed the definitions and submitted comments to Committee A-6 and the definitions in their revised form are being submitted as tentative at the 1929 annual meeting.

Definitions of Terms Relating to Timber.—Committee D-7 on Timber has had under consideration for the past few years the submission of new definitions of terms. These have been discussed with Committee E-8 and certain modifications suggested by the Editorial Committee. The definitions as revised are being submitted this year for publication as tentative, together with revisions of some of the present standard definitions of terms relating to timber.

Committee E-8 understands that Committee D-9 on Electrical Insulating Materials and Committee D-18 on Natural Building Stones have definitions of terms in preparation.

The definitions recommended for advancement to standard have been submitted to letter ballot of the committee with the following results:

Item	Affirmative	Negative	Not Voting
I. ADVANCEMENT TO STANDARD OF TENTATIVE DEFINITIONS			
1. Tentative Specifications for Tolerances and Test Methods for Asbestos Yarns (D 299 - 28 T) (Asbestos Yarn, Plain Asbestos Yarn, Metallic Asbestos Yarn, Cut, Ply)	29	1	6

This report has been submitted to letter ballot of the committee, which consists of 47 members; 37 members returned their ballots, with the following results: advisory committee, 6 affirmative, and 0 negative; standing committees, 29 affirmative, and 2 negative.

Respectfully submitted on behalf of the committee,

CLOYD M. CHAPMAN,
Chairman.

R. E. HESS,
Ex-Officio Secretary.

REPORT OF COMMITTEE E-9
ON
CORRELATION OF RESEARCH

During the year, Committee E-9 on Correlation of Research has held one meeting on December 12, 1928, at the Society's headquarters at Philadelphia, and will hold another meeting during the annual meeting of the Society.

The "List of Current and Proposed Researches and Investigations by A.S.T.M. Committees" has been kept in card index form by the Secretary, and is on file in his office. There is appended to this report a list of the titles and brief statements of research projects, from which the very considerable volume of the research work now being done under the auspices of the Society is apparent. The list does not include new projects initiated by standing committees since the 1928 annual meeting. Information regarding each project is maintained by the committee and will gladly be furnished to any member or committee of the Society upon request. Most of the listed projects are active.

This year, for the first time, the limitation of term of membership on Committee E-9 to five years causes a change in the personnel of the committee. Mr. G. H. Clamer retires with the thanks of the committee for his valuable services on this committee. The appointment of his successor will be made by the Executive Committee.

Research Committees of the Society:

Research Committee on the Effect of Tin and Arsenic on High-Speed Tool Steels.—This committee has completed a portion of its original program of tests and is reporting at this annual meeting the results of cutting and drilling tests with two sets of high-speed tools, one containing 0.50 per cent of tin and the other 0.50 per cent of arsenic. It seems clearly established that the presence of tin or arsenic in this amount distinctly reduces the efficiency and usefulness of the tool. The committee's next problem is to determine the effect of progressively smaller percentages of these elements.

Research Committee on Yield Point of Structural Steel.—The work of this committee is going forward in a very satisfactory manner. In its report to the Society last year[1] the committee presented the data from its study over a period of two years to ascertain effect of speed of loading and method of determination on the yield point of structural steel. The conclusions of the committee on this phase of its work are given in its report. During the past year the committee has carried on a new series of tests to determine the range in tensile yield point of specimens cut from common structural shapes, the relationship between yield point and ultimate strength, and the proper location in shapes from which specimens should be cut in order to furnish reliable information on yield point, ultimate strength and ductility of the shape. A report of progress on this work is being presented to the Society this year.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 105 (1928).

Research Committee on Fatigue of Metals.—The plans announced by Committee E-9 in its report last year for the development in the Society of research work in the fatigue phenomena of metals have been realized with the organization, on December 11, 1928, of the Research Committee on Fatigue of Metals. The functions of the committee have been defined broadly as: "To summarize and correlate the work that various laboratories are doing in connection with the fatigue of metals and to study the relationship between fatigue failure and other strength properties of metals and their atomic and metallographic structure." The committee has taken for its immediate tasks: (1) the preparation of abstracts of the principal articles on fatigue of metals appearing during each year; (2) the preparation of a statement of the present status of our knowledge as regards fatigue of metals; and (3) a careful study of fatigue testing machines and specimens. A second meeting was held on March 29, 1929, and the proposed work is well under way. A report of progress will be presented at this annual meeting.

Research Committee on Effect of Temperature on the Properties of Metals.—This committee functions under the joint auspices of this Society and the American Society of Mechanical Engineers. The committee has entered into an agreement with the University of Illinois to undertake fatigue tests at high temperatures on certain metals, for which about $2000 has been contributed by a number of interested companies.

Joint Committee on Investigation of the Effect of Phosphorus and Sulfur in Steel.—Studies of the effect of sulfur in forging steel, of the effect of phosphorus in steel castings, and of the effect of added phosphorus in low-carbon steel are in progress.

Sectional Committee on Specifications for Cast-Iron Pipe:

This committee, organized under the joint sponsorship of the American Water Works Association, the New England Water Works

Association, the American Gas Association and this Society, and functioning under the procedure of the American Standards Association, has for its general object the unification of specifications for cast-iron pipe. However, a great deal of investigative work is involved in carrying out this object, and extensive studies of the general questions of strength, stiffness, and toughness of cast iron and cast-iron pipe are being made. Trench load tests are now under way at the Iowa State College; and strength tests of pipe at the University of Illinois are nearing completion. Tests to determine resistance to corrosion of various kinds of cast-iron pipe in water are being carried on at the Massachusetts Institute of Technology. These research activities are being supported by funds of over $60,000 supplied by the producers and certain users of pipe.

Research Activities of Standing Committees:

The research activities of the standing committees are listed in the Appendix to this report. Many of them have been actively carried on this past year and the annual reports of the committees will contain the results of their studies. Committee E-9 understands that Project S 2, "Effect on Properties of Forgings of Amount of Reduction Between Ingot and Bloom," has been completed and will be reported to the Society through a technical paper. Project S 1, "Concrete Reinforcement Bars," has not progressed for some time, and the committee in charge is preparing a modified, less expensive program.

Funds to the extent of nearly $10,000 have been raised by Committees B-3 and B-2 for the support of the Corrosion Studies of Non-Ferrous Metals and Alloys (Projects S 45, 46 and 47) and similar studies of Die-Casting Alloys (Project S 58), respectively in charge of these two committees.

The following new projects have been started by various standing committees of the Society. They are briefly described in the Appendix and more fully in the reports of the committees indicated:

Committee C-3 on Brick:
S 59 Weathering Characteristics of Brick.

Committee C-6 on Drain Tile:
S 60 Study of Loads upon Pipe in Wide Trenches.

Committee C-10 on Hollow Masonry Building Units:
S 61 Weathering Characteristics of Hollow Tile.

Committee D-7 on Timber:
J 7 Determination of Expansion Factors of Creosote Oil (in cooperation with the American Railway Engineering Association, American Wood Preservers Association and U. S. Bureau of Standards).

Coordinating Committee on Weathering Characteristics:

The studies by several committees of the Society of the weathering characteristics of building materials were touched upon in the report of Committee E-9 last year. At the committee's suggestion, there has been formed a small joint committee made up of one member each from five interested standing committees: C-3 on Brick, C-9 on Concrete and Concrete Aggregates, C-10 on Hollow Masonry Building Units, D-16 on Slate and D-18 on Natural Building Stones. The immediate purpose is the coordination of the work of the several committees in their studies of weathering characteristics and the stimulation of investigative work in the subject. The coordinating committee has outlined the essential phases of weathering.

Miscellaneous Subjects:

Research on Corrosion-Resistant Alloys.—The formal organization early in 1929 of the Society's newest standing committee, A–10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, is believed by Committee E-9 to provide the Society with a much needed means of investigative work on the properties of the corrosion-resistant alloys not covered by the work of existing committees.

The enlargement of the Coordinating Committee on Corrosion to include representatives of the four committees studying corrosion—A-5, A-10, B-3 and B-4—and the formation of a new Coordinating Committee on Non-Ferrous Metals and Alloys consisting of representatives from each of the "B group" committees in the Society,[1] are important steps in the correlation of the research as well as the standardization activities of these committees.

Wear Testing of Materials.—Committee E-9 has still under consideration the establishment of means within the Society for a concerted study of this problem, the importance of which is well understood and has been emphasized in papers at the last two annual meetings. It is felt that abrasive wear of materials should be considered separately from bearing (lubricated) wear, and discussions are progressing respecting a study by the Society of tests for abrasive wear.

Mineral Aggregates.—Attention is directed to the rather extensive Symposium on Mineral Aggregates that appears on the program of the present annual meeting, which is partly the outcome of discussions in the committee on the desirability of coordinating and extending the studies of mineral aggregates being carried on by several committees of the Society. It is the hope of Committee E-9 that the symposium will bring into sharp relief some of the outstanding researches that are needed in this field.

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[1] For further information respecting these committees, consult the Annual Report of the Executive Committee, p. 48.—ED.

Transverse Testing of Concrete.—A review of the technical papers presented at the annual meeting in 1928 suggested among other things the importance of tests to determine the flexural strength of concrete, a property of this material that is being specified to an increasing extent. The committee understands that Committees C-9 on Concrete and Concrete Aggregates and D-4 on Road and Paving Materials are making particular studies of this subject, the results of which should be of considerable value.

Tests of Reinforced-Concrete Bridge by North Carolina Highway Board.—Two years ago the Society through Committee E-9 undertook to cooperate in the test to destruction of a reinforced-concrete highway bridge in North Carolina, which was to be submerged in a lake to be formed in developing a water power project. The Society's representative in this project, F. E. Schmitt, has reported to Committee E-9 that nothing of importance bearing on the properties of materials had resulted in the tests of this bridge, the principal value of the tests having been with respect to matters of design. An official report of the tests is to be published.

In looking over the general character of the work of the Society, Committee E-9 is impressed with the spirit of intellectual curiosity which seems increasingly to pervade both the standardization work and the work of pure research. The constantly increasing precision of methods of testing is worthy of note. Many tests, which a few years ago were regarded as entirely satisfactory, to-day seem to be of a degree of precision scarcely adequate for the needs of commercial inspection and testing of materials. The committees of the Society, both standardization committees and research committees, must look forward to constantly rising requirements for precision and to constantly changing standards which shall conform with the increased precision requirements.

Respectfully submitted on behalf of the committee,

H. F. MOORE,
Chairman.

C. L. WARWICK,
Ex-officio Secretary.

APPENDIX

LIST OF A.S.T.M. RESEARCH PROJECTS

There is given below a list of A.S.T.M. research projects under the following classifications:

1. Projects administered by A.S.T.M. standing committees;
2. Projects administered by A.S.T.M. research committees;
3. Projects administered by joint committees sponsored by the Society.

In general, this list records projects as of the date of the annual meeting of the Society in 1928 and does not include projects that may have been initiated by the standing committees since that meeting.

The projects are listed by brief title and index classification and in most instances there are given brief statements of the scopes of the projects. A more complete statement of the scope of each project, the manner of its administration and its present status is on file at the headquarters of the Society and information relating thereto will gladly be furnished to any committee or member of the Society upon request.

The standing committees of the Society whose names do not appear in the list fall in two classes: first, those whose activities have not involved any research in materials; and second, those that are devoting their major attention to methods of testing, in connection with which they are conducting many investigations (some of considerable magnitude) but which are not intended primarily to promote knowledge of the materials with which the committees are working and do not lend themselves to listing as specific projects. Information regarding the investigative work of such committees is, however, included in the files in the Secretary-Treasurer's office and is available for consultation.

PROJECTS ADMINISTERED BY A.S.T.M. STANDING COMMITTEES

Committee A-1 on Steel:

S 1. Concrete Reinforcement Bars (jointly with Committee C-2).

Investigation of the physical properties of concrete reinforcement bars, plain, deformed and twisted, rolled from four different grades of steel now in commercial use, in the form as rolled and in machined test specimens.

S 2. Effect on Properties of Forgings of Amount of Reduction Between Ingot and Bloom.

Effect on properties of forgings of amount of reduction between ingot and bloom. Includes tests of blooms with reductions from the ingot of two to one, three to one and four to one, both without treatment and annealed; also tests of rounds of several diameters, both pressed and hammered from billets made from the blooms.

S 42. Study of Single *versus* Double Welding of Lap-Welded Steel Pipe.

A study of the relative efficiency and economy of single *versus* double welded pipe for flanging. The results of this investigation will have a direct bearing on specification requirements.

Project completed. For final report see *Proceedings* Am. Soc. Testing Mats., Vol. 27, Part I, p. 115 (1927).

S 44. Size and Location of Test Coupon in Steel Castings.

To study size and location of coupons in steel castings.

Project completed. For final report see *Proceedings* Am. Soc. Testing Mats., Vol. 27, Part I, p. 114 (1927).

Committee A-2 on Wrought Iron:

S 3. Quality of Wrought Iron as Influenced by Manufacture and Heat Treatment.

Quality of wrought iron as influenced by manufacture and heat treatment. It is particularly contemplated to study the influence of raw material and processes of manufacture on puddled wrought iron.

S 4. Annealing of Wrought-Iron Chain (jointly with Committee A-4).

Effect of heat treatment of wrought iron in special cases, such as chain and other articles where the metal has been brought to a high temperature for welding; including the desirability of annealing iron chain at intervals; also red shortness of wrought iron when subjected to mechanical work at temperatures around 1500° F.

Committee A-3 on Cast Iron:

S 5. Arbitration Test Bar for Cast Iron.

Study of test bars for cast iron from an international viewpoint. The object is to provide means of testing cast-iron products for export only, and no interference with the customs of the industry in the several countries is urged or contemplated.

Committee A-4 on Heat Treatment of Iron and Steel:

S 4. Annealing of Wrought-Iron Chain (jointly with Committee A-2).

Committee A-5 on Corrosion of Iron and Steel:

S 6. Atmospheric Corrosion Tests of Uncoated Sheets.

Exposure tests of bare (uncoated) steel and iron sheets under atmospheric conditions at Pittsburgh, Fort Sheridan and Annapolis.

S 7. Total Immersion Tests of Uncoated Sheets.

Tests of bare (uncoated) steel and iron sheets totally immersed in acid mine water at Calumet, Pa., in saline water at Annapolis, in city water at Washington. Also tests in open ocean water to determine the effect of corrosion on steel ship plate with and without copper when riveted with rivets of iron and steel with varying copper contents.

S 8. Atmospheric Corrosion Tests of Metallic Coated Products.

Comprehensive field tests at several locations representing varying atmospheric conditions on metal products coated by various processes, *e.g.*, hot-dipped galvanized sheets, wire products, structural shapes and castings; sherardized castings; electrozinc-plated castings; zinc-coated sprayed castings and structural shapes; terne-coated sheets; lead-coated sheets; cadmium-plated castings; and calorized castings. An important purpose of the tests is to correlate results of service with various types of laboratory, including accelerated, tests.

S 9. Accelerated Corrosion Tests.

Study of various methods of accelerated corrosion tests with particular reference to their application to metallic coated products. Related to the atmospheric exposure tests mentioned in S 6 and S 8. The main purpose is to find some tests which will give results indicative of what really occurs in service.

S 50. Metal Culvert Corrosion Tests.

A study of the corrosion of corrugated flexible metal culvert—in the beginning from a service standpoint as a material and not as a structure. Later it is planned to determine the suitability and comparative value of the different types of base metals used in flexible culvert construction and under varying soil and other conditions.

Later the study of cast-iron culvert may be taken up.

Committee A-8 on Magnetic Analysis:

S 10. Study of Magnetic Properties of Steel and Their Correlation with Other Properties and with General Performance.

Committee B-2 on Non-Ferrous Metals and Alloys:

S 11. Test Bars for Cast Non-Ferrous Alloys.

A study of the best type of test bars for various cast non-ferrous alloys. The relationship between properties of the test bars and properties of the metal in the castings they represent is involved in this project.

S 12. General Study of Properties of Babbitt Metal.

This project includes determination of physical properties of white metal bearing alloys in the A.S.T.M. tentative standards; correct pouring temperatures of Babbitt metal; effect of ratio of length to diameter in compression testing of Babbitt metal; and effect of impurities on the properties of Babbitt metal, such as friction and wearing properties, fluidity, brittleness, and amount of drossing.

S 58. Investigation of Die-Casting Alloys.

An extensive investigation of die-casting alloys as to composition, strength, hardness, brittleness and resistance to corrosion. 50,000 specimens of various aluminum-base alloys and 25,000 specimens of zinc-base alloys are now being tested. The investigation will supply dependable information on the properties of alloys suitable for die-castings and will probably lead to the formulation of specifications based either on the alloys tested or on alloys developed as a result of the investigation.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys:

S 13. Standardization of the Practice of Corrosion-Resistance Testing.

A study of four corrosion tests, namely, total immersion, alternate immersion, spray, and accelerated electrolytic. Six non-ferrous metals will be tested by a number of cooperating laboratories each following carefully prescribed methods and reporting data on standardized forms.

S 45. Atmospheric Corrosion of Non-Ferrous Metals and Alloys.

Atmospheric corrosion tests of a variety of non-ferrous metals and alloys in the form of rolled sheet or strip 0.035 in. thick.

S 46. Corrosion of Non-Ferrous Metals and Alloys in Liquids—Field Tests.

Testing in the field of the corrosion of metals in several common solutions under conditions representative of those existing in some industrial process which is in general use. (The metals to be included will be limited to those which may reasonably be expected to prove practicable for use in each process.) Four solutions planned are sodium hydroxide, hydrochloric acid, sodium chloride and sulfuric acid.

S 47. Galvanic and Electrolytic Corrosion of Non-Ferrous Metals and Alloys.

Study of galvanic effects (that is effect of contact between dissimilar metals upon the rate of corrosion of each) and electrolytic action in three liquid media of high, medium and low conductivity.

Committee B-4 on Metallic Materials for Electrical Heating:

S 48. Growth of Nickel-Chromium Resistor Materials Due to Continued and Repeated Heating.

Study of growth of nickel-chromium resistor materials due to continued and repeated heating in order to determine whether the phenomenon commonly described as growth is such in the true sense of the word or is the result of plastic flow of the metal at high temperature.

S 49. Life Test for Durability of Electrical Resistance Wire at High Temperatures.

To arrive at the best methods for determining the durability of resistance wire at high temperatures with due regard to service conditions.

Committee C-1 on Cement:

S 14. Compressive Strength Test of Cement Mortars.

Development of satisfactory commercial test for compressive strength of portland-cement mortars. Specification requirements are involved.

S 15. Development of Shorter Time Strength Test.

Consideration of suggestion that a three-day or four-day mortar strength test be developed for portland cement.

S 16. Sulfuric Anhydride and Magnesia Content of Cement.

Consideration of proposed changes in requirements for sulfuric anhydride and magnesia in portland cement.

S 43. Fluid Cement-Water Mixtures.

This project includes tension and compression tests of fluid portland cement-water mixtures, including day-to-day uniformity of strength test, effect of varying quantity of mixing water and study of flow cylinder test for consistency of fluid cement-water mixtures.

Project completed. For final report see *Proceedings,* Am. Soc. Testing Mats., Vol., 28, Part I, p. 261 (1928).

Committee C-2 on Reinforced Concrete:

S 1. Concrete Reinforcement Bars (jointly with Committee A-1).

Committee C-3 on Brick:

S 18. Study of Test for Compressive Strength of Brick.

S 19. Present Condition of Bricks in Old Buildings.

To obtain, record and correlate information about the present condition of bricks in old buildings.

S 59. Weathering Characteristics of Brick.

Committee C-4 on Clay and Cement-Concrete Pipe:

S 20. Chemical Test Requirements for Sewer Pipe.

To determine resistance of clay and cement-concrete sewer pipe to chemical actions. (The problem is being approached largely from the point of view of specification requirements.)

Committee C-6 on Drain Tile:

S 21. Chemical Test Requirements for Drain Tile.

Development of chemical tests and chemical test requirements for drain tile to determine their resistance to the action of alkalies and acids in the soil. (In cooperation with other organizations.)

S 60. Study of Loads upon Pipe in Wide Trenches.

A study of the loads upon pipe when the trench widths are increased from those ordinarily used in firm soils to those encountered in unsheeted trenches in unstable soils, and for trenches with both vertical and sloping sides. (Investigation is being carried on under cooperative agreement between the Iowa Engineering Experiment Station and the Clay Products Association.)

Committee C-7 on Lime:

S 22. Cause of Plasticity.

A general investigation of the property of plasticity as relates to lime and lime products. Includes a study of relation between plasticity of lime-sand mortar and sand-carrying capacity of lime.

Committee C-9 on Concrete and Concrete Aggregates:

S 23. Design of Concrete.

Analyzing the existing data on various theories of proportioning concrete mixtures, and of developing an adequate theory of design.

S 36. Field Tests of Concrete.

Standardization of methods of making field specimens, including sampling of the concrete when soft, the methods of sampling hardened concrete, and the development of field tests for concrete. Investigation of the relations that may exist between the strengths of test specimens of different forms and dimensions. Relation between the compressive strength of test cylinders made in accordance with the A.S.T.M. standard method and prisms removed from slabs of the same mix.

S 38. Deleterious Substances in Concrete.

A study of the various naturally or accidentally occurring materials in concrete which may affect it deleteriously.

S 39. Admixtures in Concrete.

A general study of admixtures which may be added to concrete for the purpose of improving some of its properties.

S 40. Conditions Affecting Durability of Concrete in Structures.

Study of the conditions under which concrete has not been durable. It will emphasize the precautions which must be taken to produce good concrete, whether in methods, materials or workmanship.

S 41. Elastic Properties of Concrete.

Studies of the elastic properties of concretes of different mixtures at different ages under different conditions of moisture, the effect of different aggregates, a determination of the modulus of elasticity of concrete in tension, establishment of Poisson's ratio, and establishment of the effect of brief application of loads including loads applied suddenly or with impact; also studies of the form of specimens, type of bearing, rate of application of load, sensitivity of measuring devices, etc.

Committee C-10 on Hollow Masonry Building Units:

S 61. Weathering Characteristics of Hollow Masonry Building Units.

Committee D-1 on Preservative Coatings for Structural Materials:

S 24. Paint Vehicles.

General studies of properties and methods of tests of paint vehicles, such as linseed oil, tung oil, soya bean oil, etc.

S 25. Varnish.

General studies of properties and methods of tests of varnish.

S 26. Turpentine and Other Paint Thinners.

General studies of properties and methods of tests of turpentine and other paint thinners.

S 27. Shellac.

General studies of properties and methods of tests of shellac and shellac varnish. Most of the sub-committee's work is expected to lead to standard specifications and methods of test.

S 28. Preparation of Iron and Steel Surfaces for Painting.

Study of influence of various methods of preparing iron and steel surfaces upon the life of painted sheets, under atmospheric exposure.

S 29. Anti-Corrosive and Anti-Fouling Paints.

Study of the value of various anti-corrosive and anti-fouling paints.

S 30. Physical Properties of Paint Materials.

A study of the physical problems connected with paints and paint materials. Viscosity and plasticity of paints and color and optical properties of paints and paint materials have first been considered.

Committee D-11 on Rubber Products:

S 54. Abrasion Tests of Rubber Products.

A test being developed for the general application to those rubber products where abrasion in service is the most important element in determining the life of the material, such as conveyor belting, automobile tires, rubber-covered air and water hose, rubber heels, etc.

S 55. Life Tests of Rubber Products.

Accelerated aging test of various types of rubber compound in comparison with natural aging of the same samples.

S 56. Flexing Tests of Rubber Products.

A study of accelerated flexing tests of rubber products, especially of rubber belting, under conditions involving the deteriorating influences encountered in actual service. The results are correlated with actual service experience.

S 57. Shock Absorption of Rubber Products.

Study, development and standardization of methods of test which are particularly suitable in the evaluation of rubber stocks for shackles, motor supports, bumpers and shock insulators.

Committee D-14 on Screen Wire Cloth:

S 32. Relative Life of Various Screen Wire Cloth.

To determine the relative life of the higher grade screen wire cloths when exposed to various atmospheric agencies, such as corrosion and wind, as they exist in different localities and climates, so that purchasers of such material may make an economic selection best suited to their particular conditions.

Committee D-16 on Slate:

S 51. Abrasive Hardness of Slate.

To determine the wearing qualities of slate when used in floors, treads, etc.

S 52. Weathering Characteristics of Slate.

General study of the weathering characteristics of slate including both accelerated weathering test and observation of behavior under atmospheric conditions. Includes also study of chemical content of different slate and effect of acid on those slates.

S 53. Investigation of Sand Used for Rubbing Slate.

Committee E-4 on Metallography:

S 33. Thermal Analysis of Metals.

Study of thermal analysis of metals, including standard methods.

S 34. Study of Micro-Hardness.

A study of methods for obtaining "scratch" or "scoring" hardness making use of a special instrument designed for this purpose.

Project completed. For final report see *Proceedings* Am. Soc. Testing Mats., Vol. 26, Part I, p. 572 (1926).

S 35. X-ray Metallography.

A study of the applications of the X-ray (1) in the location of cavities, cracks and other structural variations in metals (Metal Radiography) and (2) to determine the arrangement of atoms or molecules in crystals, size of grain in crystallin aggregates and the orientation of such crystallin material (X-ray Crystallography).

PROJECTS ADMINISTERED BY A.S.T.M. RESEARCH COMMITTEES

R 1. Effect of Arsenic and Tin upon High-Speed Tool Steels.

R 2. Yield Point of Structural Steel.

The committee will consider (*a*) what is the range in yield point of structural steel (that is, low-carbon, medium-carbon, silicon and nickel steels), due to a number of important factors, when furnished under specifications; and (*b*) what testing procedure will insure sufficiently accurate determination of the yield point at minimum expense.

The following reports on item (*b*) have been made:

Proceedings, Am. Soc. Testing Mats., Vol. 27, Part I, p. 646 (1927); also Vol. 28, Part I, p. 105 (1928).

R 3. Fatigue of Metals.

The broad purpose of the committee is to summarize and correlate the work that various laboratories are doing in connection with the fatigue of metals and to study the relationship between fatigue failure and other strength properties of metals and their atomic and metallographic structure.

The committee has taken for its immediate tasks: (1) the preparation of abstracts of the principal articles on fatigue of metals appearing during each year; (2) the preparation of a statement of the present status of our knowledge as regards fatigue of metals; (3) a careful study of fatigue testing machines and specimens.

PROJECTS ADMINISTERED BY JOINT COMMITTEES SPONSORED BY THE SOCIETY

J 1. Effect of Temperature upon the Properties of Metals. Joint committee of A.S.T.M. and A.S.M.E.

The functions of the committee are essentially threefold: (1) an accumulation of service data of various metals under extreme temperatures; (2) studies leading to standardization procedure for testing metals at high and low temperatures; (3) outlining and fostering new research work in this field, giving consideration first to the various metals and alloys intended for high-temperature service in power stations, oil refineries, etc.

J 2. Effect of Phosphorus and Sulfur in Steel. Joint committee under the auspices of eleven organizations.

The committee was organized to study the effects of residual and added sulfur and phosphorus in steels of the following classifications: low-carbon steels, such as rivet steel; medium-carbon structural steels; forging steels; rail steels; spring steels; and steel castings. It was later decided to omit the spring steel group and the study of effect of sulfur on steel castings.

The following portions of the work have been completed:

Effect of Sulfur on Rivet Steel.—For reports see *Proceedings*, Vol. 22, Part I, p. 94 (1922); Vol. 24, Part I, pp. 96 and 108 (1924); and Vol. 26, Part I, p. 114 (1926).

Effect of Sulfur on Structural Steel.—For reports see *Proceedings*, Vol. 24, Part I, p. 185 (1924); Vol. 27, Part I, p. 135 (1927).

Effect of Added Sulfur on Structural, Forging and Rail Steels.—For report see *Proceedings*, Vol. 23, Part I, p. 105 (1923).

The following studies are now being made: Effect of Sulfur on Forging Steel; Effect of Phosphorus in Steel Castings; Effect of Added Phosphorus in Low-Carbon Steel.

J 3. Concrete Culvert Pipe. Joint committee under the auspices of seven organizations.

This committee is essentially concerned with standardization of specifications but has conducted some studies of loading on culvert pipe.

J 4. Concrete and Reinforced Concrete. Joint committee under the auspices of five organizations.

This committee is essentially concerned with standardization of specifications but has sponsored some investigative work.

J 5. Sectional Committee on Specifications for Cast-Iron Pipe. Sectional committee under the auspices of the American Standards Association, sponsored by four organizations.

This committee is essentially concerned with standardization of specifications but has found it necessary to carry on some extensive investigative work along the following lines: (1) trench load tests of pipe; (2) strength tests of pipe and specimens; and (3) corrosion of cast-iron pipe in water.

J 6. Inclusions in Forgings. Joint committee of A.S.T.M. and A.R.A.

Investigation of inclusions in forgings, particularly slag inclusions.

J 7. Determination of Expansion Factor of Creosote Oil. Joint committee under auspices of four organizations.

Development of a more accurate method of determining expansion factors of creosote oil.

In addition to the above research projects under the sole or joint auspices of the Society, the Society is represented upon the following projects under other auspices:

O 1. Molding Sand Research.

O 2. Research on Metal Springs.

O 5. Highway Research.

O 6. Pattern Equipment Standardization.

O 7. Corrosion Committee, American Society of Refrigerating Engineers.

O 9. Welding.

O 10. Investigation of Effect of Annealing on Chain.

O 11. Joint Committee on Boiler Feed Water Studies.

O 12. Joint Research Committee on Welding of Pressure Vessels.

The Society is also officially represented on the Division of Engineering and Industrial Research of the National Research Council.

A.S.T.M.
TENTATIVE STANDARDS

SUBMITTED OR REVISED
AT THE
1929 ANNUAL MEETING

The term Tentative Standard is applied to a proposed Standard which is printed for one or more years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action toward its adoption as standard.

Members of the Society and others are invited to direct written criticism of any of these Tentative Standards to the officer of the appropriate committee, whose name and address appear in the footnote to the title of each Tentative Standard.

TENTATIVE SPECIFICATIONS

FOR

CARBON-STEEL FORGINGS FOR LOCOMOTIVES[1]

A.S.T.M. Designation: A 20 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. These specifications cover untreated, annealed, and normalized and tempered carbon-steel driving axles, engine and trailing-truck axles, main and side rods, straps, crank pins, piston rods, and annealed car and tender axles.

Basis of Purchase. 2. The manufacturer may, at his option, furnish annealed forgings when untreated forgings are specified by the purchaser, provided they conform to the requirements specified for untreated forgings.

MANUFACTURE

Process. 3. The steel shall be made by either or both of the following processes: open-hearth or electric-furnace.

Discard. 4. A sufficient discard shall be made from each ingot to secure freedom from injurious piping and undue segregation.

Prolongations for Tests. 5. Unless otherwise specified, for test purposes at least 20 per cent of the forgings shall be provided with prolongations or, at the manufacturer's option, a forging may be selected.

Boring. 6. If boring is specified, it shall be performed before heat-treatment and the diameter of the hole shall be at least 20 per cent of the maximum outside diameter or thickness of the forging, exclusive of collars and flanges.

Heat Treatment. 7. (*a*) *Cooling.*—After forging, the objects shall be allowed to cool to a temperature below the critical range, under suitable conditions to prevent injury by too rapid cooling.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. V. H Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

These tentative specifications are in effect a revision of the former Standard Specifications for Carbon-Steel Forgings for Locomotives (A.S.T.M. Designation: A 20 – 28) which were discontinued in 1929.

(*b*) *Annealing.*—For annealing, the forgings shall be uniformly reheated to the proper temperature to refine the grain and allowed to cool uniformly. A group thus treated shall be known as an "annealing charge."

(*c*) *Normalizing.*—For normalizing, the forgings shall be uniformly reheated to a proper temperature to refine the grain, and after being held a sufficient length of time at this temperature, shall be withdrawn from the furnace and allowed to cool uniformly in the atmosphere, protected from rain or snow, to a temperature below the critical range. A group of forgings thus heated shall be known as a "normalizing charge." Normalizing, when specified, shall be followed either by annealing as described in Paragraph (*b*), or by tempering as described in Paragraph (*d*).

(*d*) *Tempering.*—For tempering, after normalizing as described in Paragraph (*c*), the forging shall be uniformly reheated to a temperature below the critical range, and after being held a proper time at this temperature shall be allowed to cool uniformly either in the furnace or in the atmosphere protected from rain or snow. A group of forgings thus treated shall be known as a "tempering charge."

CHEMICAL PROPERTIES AND TESTS

Chemical Composition.

8. The steel shall conform to the following requirements as to chemical composition:

Manganese	For untreated forgings	0.50 to 0.80 per cent
	For heat-treated forgings	0.60 to 0.90 per cent
Phosphorus		not over 0.05 per cent
Sulfur		not over 0.05 per cent

Ladle Analyses.

9. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon and the elements specified in Section 8. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and the percentages of manganese, phosphorus and sulfur shall conform to the requirements specified in Section 8.

Check Analyses

10. An analysis may be made by the purchaser from a forging representing each melt The chemical composition thus determined shall conform to the requirements specified in Section 8. Drillings for analysis may be taken from the forging or from a full-size prolongation of the same, at any point midway between the center and surface; or turnings may be taken from a test specimen.

PHYSICAL PROPERTIES AND TESTS

Tension Tests.

11. (*a*) The forgings shall conform to the minimum requirements as to tensile properties specified in Table I.

(*b*) The classification by size of the forging shall be determined by the specified diameter or thickness which governs the size of the prolongation from which the test specimen is taken.

(*c*) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the testing machine, by which is meant the speed of the cross-head when the machine is running idle, shall not be less than $\frac{1}{16}$ nor more than $\frac{1}{8}$ in. per minute.

TABLE I.—MINIMUM TENSILE REQUIREMENTS

FOR FORGINGS WHOSE MAXIMUM OUTSIDE DIAMETER OR OVER-ALL THICKNESS IS NOT OVER 12 IN. WHEN UNTREATED AND NOT OVER 20 IN. WHEN TREATED.

Size, Outside Diameter or Over-all Thickness	Tensile Strength, lb. per sq. in.	Yield Point, lb. per sq. in.	Elongation in 2 in., per cent		Reduction of Area per cent	
			Inverse Ratio	Not Under	Inverse Ratio	Not Under
UNTREATED						
Not over 8 in.	75 000	0.5 tens. str.	$\frac{1\,600\,000}{\text{Tens. str.}}$	18	$\frac{2\,200\,000}{\text{Tens. str.}}$	24
Over 8 to 12 in., inclusive	75 000	0.5 tens. str.	$\frac{1\,500\,000}{\text{Tens. str.}}$	17	$\frac{2\,000\,000}{\text{Tens. str.}}$	23
ANNEALED						
Not over 8 in., 4-in. maximum wall	80 000	0.48 tens. str.	$\frac{1\,980\,000}{\text{Tens. str.}}$	22	$\frac{3\,100\,000}{\text{Tens. str.}}$	35
Over 8 to 12 in., 6-in. maximum wall	80 000	0.48 tens str.	$\frac{1\,900\,000}{\text{Tens. str.}}$	21	$\frac{2\,900\,000}{\text{Tens. str.}}$	33
Over 12 to 20 in., 10-in. maximum wall	80 000	0.48 tens. str.	$\frac{1\,820\,000}{\text{Tens. str.}}$	20	$\frac{2\,640\,000}{\text{Tens. str.}}$	31
NORMALIZED AND TEMPERED						
Not over 8 in., 4-in. maximum wall	85 000	0.52 tens. str.	$\frac{2\,300\,000}{\text{Tens. str.}}$	25	$\frac{3\,650\,000}{\text{Tens. str.}}$	40
Over 8 to 12 in., 6-in. maximum wall	83 000	0.52 tens. str.	$\frac{2\,100\,000}{\text{Tens. str.}}$	23	$\frac{3\,320\,000}{\text{Tens. str.}}$	37
Over 12 to 20 in., 10-in. maximum wall	83 000	0.52 tens. str.	$\frac{2\,000\,000}{\text{Tens. str.}}$	22	$\frac{3\,100\,000}{\text{Tens. str.}}$	35

(*d*) Tests of forgings shall be made only after final heat-treatment.

Bend Tests.

12. If specified by the purchaser, bend tests shall be made on annealed, and normalized and tempered forgings as follows: The test specimen shall stand being bent cold through 180 deg. around a pin $\frac{1}{2}$ in. in diameter without cracking on the outside of the bent portion.

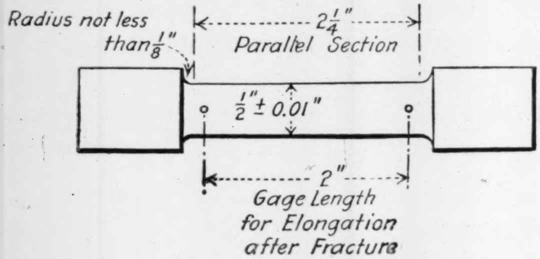
Test Specimens.

13. (*a*) Tension and bend test specimens shall be taken from a full-size prolongation of any forging. For forgings with large ends or collars, the prolongation may be of the same cross-section as that of

the forging back of the large end or collar. If approved by the purchaser, the specimens may be taken from the forging itself with a hollow drill.

(*b*) The axis of the specimen shall be located at any point midway between the center and surface of solid forgings, and at any point midway between the inner and outer wall surfaces of bored forgings and shall be parallel to the axis of the forging in the direction in which the metal is most drawn out.

(*c*) Tension test specimens shall conform to the dimensions shown in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.


Radius not less than $\frac{1}{8}$"
$2\frac{1}{4}$"
Parallel Section
$\frac{1}{2}$" ± 0.01"
2"
Gage Length for Elongation after Fracture

Note:- The Gage Length, Parallel Section, and Fillets shall be as Shown, but the Ends may be of any Shape to fit the Holders of the Testing Machine in such a Way that the Load shall be axial.

FIG. 1.

(*d*) Bend test specimens shall be $\frac{1}{2}$-in. square in section with corners rounded to a radius of not over $\frac{1}{16}$ in. and the length need not exceed 6 in.

Number of Tests. 14. Unless otherwise specified by the purchaser, tests shall be made as follows:

(*a*) For untreated forgings, one tension test shall be made from each melt.

(*b*) For annealed forgings, one tension test shall be made from each annealing charge. If more than one melt is represented in an annealing charge, one tension test shall be made from each melt.

(*c*) For normalized and tempered forgings, one tension test, and when specified one bend test, shall be made from each tempering charge. If more than one normalizing charge is represented in a tempering charge, one tension test, and when specified one bend test, shall be made from each normalizing charge. If more than one melt is represented in a normalizing charge, one tension test, and when specified one bend test, shall be made from each melt.

(*d*) If more than one class of forgings by size is represented in any lot, one tension test, and when specified one bend test, from a forging of each class by size shall be made in accordance with Sections 11, 12 and 13.

(*e*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*f*) If the percentage of elongation of any test specimen is less than that specified in Section 11 (*a*) and any part of the fracture is more than $\frac{3}{4}$ in. from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Retests. 15. (*a*) If the results of the physical tests of any test lot do not conform to the requirements specified, the manufacturer may re-treat such lot, but not more than three additional times unless authorized by the purchaser, and retests shall be made as specified in Section 14.

(*b*) When annealed, or normalized and tempered forgings are specified, if the fracture of any test specimen shows over 15 per cent crystallin, a second test shall be made. If the fracture of the second specimen shows over 15 per cent crystallin, the forgings represented by such specimen shall be re-treated. The fracture shall be considered crystallin if the crystals which it contains are so large that the cleavage planes or sides of these crystals are easily visible to the naked eye.

WORKMANSHIP AND FINISH

Workmanship. 16. The forgings shall conform to the sizes and shapes specified by the purchaser. When centered, 60-deg. centers with clearance drilled for points shall be used.

Finish. 17. The forgings shall be free from injurious defects and shall have a workmanlike finish.

MARKING

Marking. 18. Identification marks shall be legibly stamped on each forging and on each test specimen. The purchaser shall indicate the location of such identification marks.

INSPECTION AND REJECTION

Inspection. 19. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the forgings ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the forgings are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of the forgings in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection. 20. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 19(*b*) shall be reported within five working days from the receipt of samples.

(*b*) Forgings which show injurious defects while being finished by the purchaser will be rejected, and the manufacturer shall be notified.

Rehearing. 21. Samples tested in accordance with Section 19(*b*), which represent rejected forgings, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

TENTATIVE SPECIFICATIONS
FOR
MARINE BOILER STEEL PLATES[1]

A.S.T.M. Designation: A 114-29 T

This is a Tentative Standard, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1927; REVISED, 1928, 1929.

Scope.

1. These specifications cover two grades of steel for marine boilers, namely: Grade A and Grade B.

MANUFACTURE

Process.

2. The steel shall be made by the open-hearth process.

CHEMICAL PROPERTIES AND TESTS

Chemical Composition.

3. The steel shall conform to the following requirements as to chemical composition:

Phosphorus	Acid	not over 0.04 per cent
	Basic	" " 0.035 " "
Sulfur		" " 0.04 " "

Ladle Analyses

4. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus, and sulfur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and the percentages of phosphorus and sulfur shall conform to the requirements specified in Section 3.

Check Analyses.

5. An analysis may be made by the purchaser from the tension test specimen representing the bottom of each plate as rolled. The chemical composition thus determined shall conform to the requirements specified in Section 3.

PHYSICAL PROPERTIES AND TESTS

Tension Tests.

6. (*a*) The material shall conform to the following requirements as to tensile properties:

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

	GRADE A	GRADE B
Tensile strength, lb. per sq. in....	60 000 – 70 000	55 000 – 65 000
Yield point, min., lb. per sq. in....	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min., per cent.	$\frac{1\,500\,000}{\text{tens. str.}}$	$\frac{1\,550\,000}{\text{tens. str.}}$

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Modification in Elongation.

7. For material over $\frac{3}{4}$ in. in thickness, a deduction from the percentages of elongation specified in Section 6 (*a*) of 0.125 per cent shall be made for each increase of $\frac{1}{32}$ in. of the specified thickness above $\frac{3}{4}$ in. to a minimum of 20 per cent for Grade A steel and 22 per cent for Grade B steel.

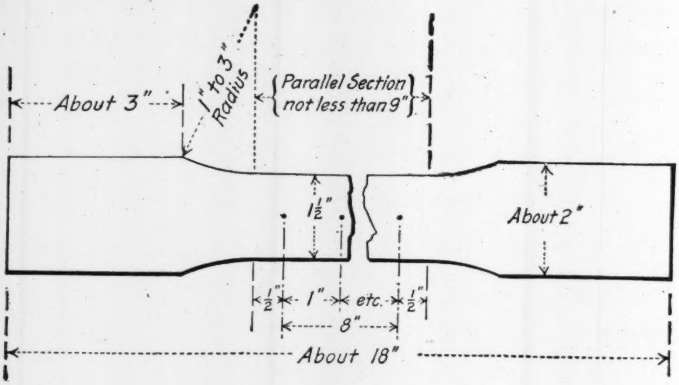

FIG. 1.

Bend Tests.

8. (*a*) The test specimen for Grade A steel shall stand being bent cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to 1½ times the thickness of the specimen; for material over 1 in. to and including 1½ in. in thickness, around a pin the diameter of which is equal to three times the thickness of the specimen; and for material over 1½ in. in thickness, around a pin the diameter of which is equal to four times the thickness of the specimen.

(*b*) The test specimen for Grade B steel shall stand being bent cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; for material over 1 in. to and including 1½ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen; and for material over 1½ in. in thickness, around a pin the diameter of which is equal to three times the thickness of the specimen.

Test Specimens.

9. (*a*) The tension test specimens shall be taken longitudinally from the finished rolled material. In the case of plates rolled from ingots, these specimens shall be taken in the direction of the longitudinal axis of the ingot; one from the top and one from the bottom on the same side of the plates as rolled. In the case of plates rolled from slabs, the tension test specimens shall be taken from diagonal corners

(*b*) In the case of plates rolled from ingots, the bend test specimen shall be taken from the middle of the top of the finished rolled material at right angles to the longitudinal axis of the ingot. In the case of plates rolled from slabs, it shall be taken from the middle of one end at right angles to the longitudinal axis of the plate as rolled.

TABLE I.—PERMISSIBLE OVERWEIGHTS OF RECTANGULAR PLATES ORDERED TO THICKNESS.

ORDERED THICKNESS, IN.	PERMISSIBLE EXCESS IN AVERAGE WEIGHTS PER SQUARE FOOT OF PLATES FOR WIDTHS GIVEN, EXPRESSED IN PERCENTAGES OF NOMINAL WEIGHTS.									OREDRED THICKNESS, IN.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over.	
Under $\frac{1}{8}$	9	10	12	14	..	..	..	..	..	Under $\frac{1}{8}$
$\frac{1}{8}$ to $\frac{3}{16}$ excl.	8	9	10	12	..	..	..	..	..	$\frac{1}{8}$ to $\frac{3}{16}$ excl.
$\frac{3}{16}$ to $\frac{1}{4}$ excl.	7	8	9	10	12	..	..	..	..	$\frac{3}{16}$ to $\frac{1}{4}$ excl.
$\frac{1}{4}$ to $\frac{5}{16}$ excl.	6	7	8	9	10	12	14	16	19	$\frac{1}{4}$ to $\frac{5}{16}$ excl.
$\frac{5}{16}$ to $\frac{3}{8}$ excl.	5	6	7	8	9	10	12	14	17	$\frac{5}{16}$ to $\frac{3}{8}$ excl.
$\frac{3}{8}$ to $\frac{7}{16}$ excl.	4.5	5	6	7	8	9	10	12	15	$\frac{3}{8}$ to $\frac{7}{16}$ excl.
$\frac{7}{16}$ to $\frac{1}{2}$ excl.	4	4.5	5	6	7	8	9	10	13	$\frac{7}{16}$ to $\frac{1}{2}$ excl.
$\frac{1}{2}$ to $\frac{5}{8}$ excl.	3.5	4	4.5	5	6	7	8	9	11	$\frac{1}{2}$ to $\frac{5}{8}$ excl.
$\frac{5}{8}$ to $\frac{3}{4}$ excl.	3	3.5	4	4.5	5	6	7	8	9	$\frac{5}{8}$ to $\frac{3}{4}$ excl.
$\frac{3}{4}$ to 1 excl.	2.5	3	3.5	4	4.5	5	6	7	8	$\frac{3}{4}$ to 1 excl.
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

(*c*) Tension and bend test specimens shall be of the full thickness of the material as rolled, and shall be machined to the form and dimensions shown in Fig. 1; except that bend test specimens may be machined with both edges parallel.

(*d*) The machined sides of rectangular bend test specimens may have the corners rounded to a radius not over $\frac{1}{16}$ in.

Number of Tests.

10. (*a*) Two tension tests and one bend test shall be made from each plate as rolled.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 6 (*a*) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS

Permissible Variations.

11. The thickness of each plate shall not vary more than 0.01 in. under that ordered. The overweight of each "lot[1] in each shipment" shall not exceed the amount given in Table I. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

FINISH

Finish.

12. The finished material shall be free from injurious defects and shall have a workmanlike finish.

MARKING

Marking.

13. (*a*) The name of the manufacturer, the place where manufactured, Marine A or B, the manufacturer's test identification number, and the tensile strength as specified in Paragraphs (*b*) and (*c*) shall be legibly stamped in two places on each finished plate not less than 12 in. from the edges. Each butt strap shall be stamped near the middle of the plate. The manufacturer's identification number shall be legibly stamped on each test specimen.

(*b*) Plates not over ½ in. in thickness to be used in externally fired boilers for steamers navigated under the provisions of Title L 11, U. S. Revised Statutes, shall be stamped with the least tensile strength, expressed in thousands, as determined by the tests.

(*c*) Plates other than those described in Paragraph (*b*) shall be stamped with the minimum tensile strength specified.

(*d*) The manufacturer shall furnish facilities to the representative of the United States Steamboat Inspection Service and, when required, to the representative of the ship classification society, to place their official monogram stamp adjacent to the stamping specified in Paragraph (*a*).

INSPECTION AND REJECTION

Inspection.

14. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which con-

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[1] The term lot means all of the plates of each group width and group thickness.

cern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection.

15. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5 shall be reported within five working days from the receipt of samples.

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing.

16. Samples tested in accordance with Section 5, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

TENTATIVE SPECIFICATIONS
FOR
HEAT-TREATED CARBON-STEEL HELICAL SPRINGS[1]

A.S.T.M. Designation: A 125 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. These specifications cover hot-coiled, helical compression springs made of round bars $\frac{1}{2}$ in. and larger in diameter and suitable for use on railway equipment.

MANUFACTURE

Process. 2. The steel may be made by one or more of the following processes: open-hearth, crucible or electric-furnace. The rolled bars shall be practically straight, free from surface cracks, rolling seams, folds and flat areas, or other injurious defects.

Coiling. 3. The bars after being suitably tapered or otherwise prepared shall be heated slowly and uniformly to a temperature of approximately 1700° F. (930° C.) and coiled on a preheated mandrel. No water shall be allowed to come in contact with the heated bar at any time.

Heat Treatment. 4. After coiling, the springs shall be allowed to cool uniformly to a distinct black heat. They shall then be reheated uniformly to a temperature sufficient to refine the grain and quenched in an ample volume of oil. After quenching the springs shall be allowed to cool to at least 400° F. (200° C.) and shall then be reheated uniformly to a temperature below the critical, but sufficiently high to give a proper drawback or tempering effect.

SAMPLING

Sampling. 5. The springs offered for inspection shall be arranged in groups with 500 or fraction thereof of a size in a group. The inspector shall select one spring from each group to represent that group and shall suitably mark the sample so selected for identification.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

CHEMICAL PROPERTIES AND TESTS

Chemical Composition.

6. (*a*) Unless otherwise specified, the steel shall conform to the following requirements as to chemical composition:

Carbon, per cent	0.90 to 1.05
Manganese, per cent	0.25 to 0.50
Phosphorus, maximum, per cent	0.05
Sulfur, maximum, per cent	0.05
Silicon, per cent	0.15 to 0.30

(*b*) Other grades of steel may be used when mutually agreed upon by the purchaser and the manufacturer.

Check Analysis.

7. One check analysis may be made by the purchaser from each 500 springs or fraction thereof of each size of bar.

Preparation of Sample.

8. For chemical analysis, a spring if small shall be taken or if large a piece weighing about ½ lb. shall be cut off. If the sample is cut off hot it shall be cooled in such a way as not to permit it to harden. Drillings for check analysis shall be made from the samples so selected and the drill used shall be approximately one-half the diameter of the bar. The drillings for analysis shall be selected from the thoroughly-mixed total drillings obtained by passing nearly through the section of the bar after discarding the surface drillings.

PHYSICAL PROPERTIES AND TESTS

Number of Tests.

9. From each group of springs described in Section 5 which conform to the requirements of Sections 15 and 16 (*a*) the inspector may select 10 per cent to be tested in accordance with the requirements of Sections 10 and 11.

Physical Properties and Tests.

10. (*a*) The properties specified in Paragraphs (*b*) to (*f*) shall be determined in the order enumerated. The springs shall not be rapped or otherwise disturbed during the test.

(*b*) *Solid Height.*—The solid height is the perpendicular distance between the plates of the testing machine when the spring is compressed solid with a test load of approximately one and one-quarter times that necessary to bring all coils in contact.

(*c*) *Free Height.*—The free height is the height of the spring when the load specified in Paragraph (*b*) has been released and is determined by placing a straight-edge across the top of the spring and measuring the perpendicular distance from the plate on which the spring stands to the straight-edge at the approximate center of the spring.

(*d*) *Loaded Height.*—The loaded height is the perpendicular distance between the plates of the testing machine when the specified working load has been applied.

TABLE I.—TEST LOADS IN POUNDS AND DEFLECTION PER TURN IN INCHES FOR HELICAL

Outside Diameter of Spring, in.		Diameter of Bar, in.									
		½	9/16	⅝	11/16	¾	13/16	⅞	15/16	1	1 1/16
2	Load	3272	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	0.134	.....	.....	.....	.....	.....	.....	.....	.....	.....
2¼	Load	2805	4140	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	0.183	0.152	.....	.....	.....	.....	.....	.....	.....	.....
2½	Load	2454	3606	5113	.....	.....	.....	.....	.....	.....	.....
	Deflection	0.239	0.200	0.168	.....	.....	.....	.....	.....	.....	.....
2¾	Load	2181	3194	4511	6187	.....	.....	.....	.....	.....	.....
	Deflection	0.303	0.254	0.216	0.185	.....	.....	.....	.....	.....	.....
3	Load	1963	2866	4036	5518	7363	.....	.....	.....	.....	.....
	Deflection	0.374	0.316	0.270	0.233	0.202	.....	.....	.....	.....	.....
3¼	Load	1785	2600	3652	4980	6627	8641	.....	.....	.....	.....
	Deflection	0.452	0.384	0.330	0.285	0.249	0.219	.....	.....	.....	.....
3½	Load	1636	2379	3334	4537	6025	7837	10022	.....	.....	.....
	Deflection	0.538	0.459	0.396	0.344	0.302	0.266	0.235	.....	.....	.....
3¾	Load	1510	2192	3065	4166	5522	7171	9150	11503	.....	.....
	Deflection	0.632	0.540	0.467	0.408	0.359	0.317	0.282	0.252	.....	.....
4	Load	1402	2033	2840	3852	5097	6608	8418	10564	13090	.....
	Deflection	0.733	0.628	0.545	0.477	0.421	0.374	0.334	0.299	0.269	.....
4¼	Load	.....	1895	2644	3581	4733	6127	7795	9767	12083	14777
	Deflection	.....	0.723	0.629	0.553	0.489	0.435	0.389	0.350	0.316	0.286
4½	Load	.....	1774	2474	3347	4418	5712	7257	9081	11220	13702
	Deflection	.....	0.824	0.718	0.632	0.561	0.500	0.449	0.405	0.366	0.333
4¾	Load	.....	.....	2324	3141	4142	5352	6789	8486	10472	12773
	Deflection	.....	.....	0.815	0.718	0.638	0.571	0.513	0.464	0.420	0.383
5	Load	.....	.....	2191	2959	3898	5030	6377	7964	9817	11962
	Deflection	.....	.....	0.916	0.810	0.720	0.646	0.582	0.527	0.479	0.436
5¼	Load	.....	.....	.....	2797	3681	4746	6013	7502	9240	11248
	Deflection	.....	.....	.....	0.906	0.808	0.725	0.654	0.594	0.540	0.494
5½	Load	.....	.....	.....	2651	3488	4493	5688	7091	8726	10614
	Deflection	.....	.....	.....	1.008	0.900	0.809	0.731	0.664	0.606	0.554
5¾	Load	.....	.....	.....	.....	3313	4266	5396	6723	8267	10049
	Deflection	.....	.....	.....	.....	0.997	0.898	0.812	0.739	0.675	0.618
6	Load	.....	.....	.....	.....	3155	4060	5133	6391	7854	9540
	Deflection	.....	.....	.....	.....	1.099	0.991	0.898	0.818	0.748	0.686
6¼	Load	.....	.....	.....	.....	.....	3874	4894	6090	7480	9080
	Deflection	.....	.....	.....	.....	.....	1.088	0.987	0.901	0.824	0.758
6½	Load	.....	.....	.....	.....	.....	3703	4676	5816	7140	8660
	Deflection	.....	.....	.....	.....	.....	1.191	1.081	0.987	0.905	0.833
6¾	Load	.....	.....	.....	.....	.....	.....	4478	5566	6829	8282
	Deflection	.....	.....	.....	.....	.....	.....	1.180	1.078	0.989	0.910
7	Load	.....	.....	.....	.....	.....	.....	4295	5337	6545	7933
	Deflection	.....	.....	.....	.....	.....	.....	1.283	1.172	1.077	0.993
7¼	Load	.....	.....	.....	.....	.....	.....	.....	5125	6283	7612
	Deflection	.....	.....	.....	.....	.....	.....	.....	1.271	1.168	1.078
7½	Load	.....	.....	.....	.....	.....	.....	.....	4930	6041	7317
	Deflection	.....	.....	.....	.....	.....	.....	.....	1.374	1.263	1.167
7¾	Load	.....	.....	.....	.....	.....	.....	.....	.....	5817	7043
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	1.363	1.259
8	Load	.....	.....	.....	.....	.....	.....	.....	.....	5610	6789
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	1.466	1.355
8¼	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8½	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8¾	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9¼	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9½	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9¾	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10½	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
11½	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
12	Load	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Deflection	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

SPRINGS, CORRESPONDING TO A MAXIMUM FIBER STRESS OF 100,000 LB. PER SQ. IN.

Diameter of Bar, in.											Outside Diameter of Spring, in.
$1\frac{1}{8}$	$1\frac{3}{16}$	$1\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{3}{8}$	$1\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{9}{16}$	$1\frac{5}{8}$	$1\frac{11}{16}$		
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$2\frac{1}{4}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$2\frac{1}{2}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$2\frac{3}{4}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$3\frac{1}{4}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$3\frac{1}{2}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$3\frac{3}{4}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$4\frac{1}{4}$
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
16567	.....	.....	.....	.....	.....	.....	.....	.....	.....	Load	$4\frac{1}{2}$
0.302	.....	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
15424	18460	.....	.....	.....	.....	.....	.....	.....	.....	Load	$4\frac{3}{4}$
0.349	0.319	.....	.....	.....	.....	.....	.....	.....	.....	Deflection	
14429	17250	20450	.....	.....	.....	.....	.....	.....	.....	Load	5
0.399	0.366	0.336	.....	.....	.....	.....	.....	.....	.....	Deflection	
13554	16185	19175	22545	.....	.....	.....	.....	.....	.....	Load	$5\frac{1}{4}$
0.452	0.416	0.383	0.353	.....	.....	.....	.....	.....	.....	Deflection	
12780	15250	18045	21200	24750	.....	.....	.....	.....	.....	Load	$5\frac{1}{2}$
0.509	0.468	0.432	0.400	0.370	.....	.....	.....	.....	.....	Deflection	
12089	14415	17040	20005	23335	27045	.....	.....	.....	.....	Load	$5\frac{3}{4}$
0.569	0.524	0.484	0.449	0.416	0.387	.....	.....	.....	.....	Deflection	
11469	13665	16145	18940	22070	25565	29450	.....	.....	.....	Load	6
0.632	0.583	0.540	0.501	0.465	0.433	0.404	.....	.....	.....	Deflection	
10910	12990	15340	17980	20940	24235	27900	31955	.....	.....	Load	$6\frac{1}{4}$
0.699	0.645	0.598	0.556	0.517	0.482	0.450	0.420	.....	.....	Deflection	
10402	12379	14610	17115	19920	23040	26505	30340	34565	.....	Load	$6\frac{1}{2}$
0.768	0.711	0.659	0.613	0.571	0.533	0.498	0.467	0.437	.....	Deflection	
9940	11823	13945	16325	18995	21955	25245	28875	32880	37275	Load	$6\frac{3}{4}$
0.841	0.779	0.724	0.674	0.628	0.587	0.550	0.515	0.483	0.454	Deflection	
9517	11314	13340	15610	18150	20970	24095	27550	31350	35520	Load	7
0.918	0.851	0.791	0.737	0.688	0.644	0.603	0.566	0.532	0.500	Deflection	
9129	10847	12780	14950	17375	20065	23050	26340	29955	33920	Load	$7\frac{1}{4}$
0.998	0.926	0.861	0.804	0.751	0.703	0.659	0.619	0.582	0.548	Deflection	
8770	10418	12270	14345	16665	19240	22090	25230	28680	32460	Load	$7\frac{1}{2}$
1.081	1.004	0.935	0.873	0.816	0.765	0.718	0.675	0.635	0.599	Deflection	
8440	10020	11800	13790	16015	18480	21205	24210	27510	31125	Load	$7\frac{3}{4}$
1.167	1.085	1.011	0.945	0.884	0.829	0.779	0.733	0.691	0.651	Deflection	
8133	9653	11360	13275	15405	17770	20390	23270	26430	29890	Load	8
1.256	1.169	1.090	1.020	0.955	0.896	0.842	0.793	0.748	0.706	Deflection	
7847	9312	10955	12795	14845	17120	19635	22400	25435	28755	Load	$8\frac{1}{4}$
1.350	1.256	1.173	1.097	1.028	0.965	0.908	0.856	0.808	0.763	Deflection	
7581	8993	10575	12350	14325	16515	18935	21590	24510	27700	Load	$8\frac{1}{2}$
1.447	1.347	1.258	1.177	1.104	1.038	0.977	0.921	0.870	0.823	Deflection	
.....	8696	10225	11935	13840	15950	18280	20840	23650	26710	Load	$8\frac{3}{4}$
.....	1.441	1.346	1.260	1.183	1.113	1.048	0.989	0.934	0.884	Deflection	
.....	8418	9895	11550	13385	15420	17670	20140	22845	25805	Load	9
.....	1.538	1.437	1.347	1.265	1.190	1.122	1.059	1.001	0.948	Deflection	
.....	.....	9585	11185	12960	14930	17100	19485	22100	24950	Load	$9\frac{1}{4}$
.....	.....	1.532	1.436	1.349	1.270	1.198	1.131	1.070	1.014	Deflection	
.....	.....	9295	10840	12565	14465	16565	18870	21395	24150	Load	$9\frac{1}{2}$
.....	.....	1.629	1.528	1.436	1.353	1.276	1.206	1.141	1.082	Deflection	
.....	.....	.....	10520	12190	14030	16065	18295	20740	23405	Load	$9\frac{3}{4}$
.....	.....	.....	1.622	1.526	1.438	1.357	1.283	1.215	1.152	Deflection	
.....	.....	.....	10220	11835	13620	15590	17755	20120	22700	Load	10
.....	.....	.....	1.720	1.619	1.526	1.441	1.363	1.291	1.225	Deflection	
.....	.....	.....	.....	11185	12870	14725	16760	18985	21410	Load	$10\frac{1}{2}$
.....	.....	.....	.....	1.811	1.709	1.615	1.530	1.450	1.377	Deflection	
.....	.....	.....	.....	.....	12200	13950	15870	17975	20260	Load	11
.....	.....	.....	.....	.....	1.903	1.800	1.705	1.618	1.537	Deflection	
.....	.....	.....	.....	.....	.....	13250	15075	17065	19230	Load	$11\frac{1}{2}$
.....	.....	.....	.....	.....	.....	1.994	1.891	1.795	1.707	Deflection	
.....	.....	.....	.....	.....	.....	.....	14350	16240	18295	Load	12
.....	.....	.....	.....	.....	.....	.....	2.086	1.981	1.885	Deflection	

(*e*) *Uniformity of Pitch.*—The pitch of the coils shall be sufficiently uniform that when the springs are compressed to a point where any two coils are in contact there shall be no space exceeding $\frac{1}{32}$ in. between the other coils, excluding the tapered ends.

(*f*) *Permanent Set.*—The permanent set is the difference, if any, between the free height and the height after the spring has been compressed solid three times with the test load specified in Paragraph (*b*), measured at the same point and in the same manner.

Tolerances. 11. (*a*) Springs having a free height of 10 in. and under shall conform to the following tolerances when tested in accordance with Section 10:

Diameter.—The diameter of the springs up to 6 in. in outside diameter shall not vary more than $\frac{1}{16}$ in. from that specified and for springs over 6 in. in outside diameter the diameter shall not vary more than $\frac{1}{8}$ in. from that specified.

Solid Height.—Not more than $\frac{1}{16}$ in. over that specified.

Free Height.—Not more than $\frac{1}{8}$ in. over or under that specified.

Loaded Height.—Not more than $\frac{1}{8}$ in. over nor more than $\frac{1}{16}$ in. under that specified.

Uniformity of Pitch.—As specified in Section 10 (*e*).

Permanent Set.—Not more than $\frac{1}{32}$ in.

Increased Tolerances. (*b*) For springs having a free height over 10 in. but not over 15 in. the tolerances specified in Paragraph (*a*) shall be increased 50 per cent.

(*c*) For springs having a free height over 15 in. but not over 20 in. the tolerances specified in Paragraph (*a*) shall be increased 100 per cent.

(*d*) For springs having a free height over 20 in. the tolerances shall be mutually agreed upon by the manufacturer and the purchaser.

Testing Stress. 12. (*a*) The properties and methods of testing specified in Sections 10 and 11 have been established on the assumption that the maximum fiber stress at the solid height shall not exceed 100,000 lb. per sq. in. and that the several heights specified are commensurate. The stress of 100,000 lb. per sq. in. referred to is given solely as a limiting stress not to be exceeded in testing. This stress is not intended as a guide in the design of springs, as the proper working fiber stress will depend upon the class of the spring and upon the service for which it is intended.

(*b*) Unless otherwise mutually agreed upon by the manufacturer and purchaser, springs which do not meet the conditions of Paragraph (*a*) shall not be subject to the requirements of Sections 10 and 11, but shall be submitted to a test load which corresponds to a maximum fiber stress of 100,000 lb. per sq. in. as determined in Section 13. The free height as measured after application and release of such test load shall conform to the requirements of Section 11.

Test Loads. 13. The test load corresponding to a maximum fiber stress of 100,000 lb. per sq. in. shall be calculated from the following equation:

$$C = \frac{3.1416\, S\, d^3}{8\, M} \qquad (1)$$

where

C = the capacity in pounds;

S = the stress at the most strained fiber = 100,000 lb. per sq. in.;

d = the diameter of the bar in inches;

M = the mean diameter of the helix in inches, found by subtracting the diameter of the bar from the outside diameter of the spring.

Table I shows test loads in pounds and deflection per turn in inches for helical springs, corresponding to a maximum fiber stress of 100,000 lb. per sq. in. for springs 2 to 12 in. in outside diameter.

Calculation. 14. To determine whether or not the specified heights fulfill the conditions of Section 12 (*a*) the calculations described in Paragraphs (*a*) to (*f*), inclusive, shall be made.

(*a*) Divide the solid height by the diameter of the bar to obtain the number of turns in the spring. From the figure thus obtained subtract one and one-half to obtain the number of acting turns.

NOTE.—There is one turn of inactive material at each end of a spring, counting from the tip of the tapered bar. In measurements parallel to the axis of the spring, this is equal to one and one-half times the diameter of the bar, being made up of the two tips of the bar, each one-quarter of the bar diameter in thickness and one full bar diameter.

(*b*) The deflection corresponding to the load determined by the equation in Section 13 shall be calculated from the following equation:

$$F = \frac{3.1416\, S\, M^2\, N}{G\, d} \qquad (2)$$

where

S, M, and d are the same as in Eq. 1;

F = the deflection;

N = the number of active turns; and

G = the effective torsional modulus of elasticity. For the grade of steel herein specified G shall be taken at 10,500,000 lb. per sq. in.

Table I shows test loads in pounds and deflection per turn in inches for helical springs, corresponding to a maximum fiber stress of 100,000 lb. per sq. in. for springs 2 to 12 in. in outside diameter.

(*c*) The sum of the solid height and the total deflection F is the "normal free height" and should not be exceeded by the free height.

(*d*) In helical springs the loads and deflections are directly proportional. Therefore, the deflection, X, under any load, P, less than the capacity shall be determined from the ratio: $C:F::P:X$ by solving for X.

(*e*) The sum of the specified loaded height and X is the required free height which shall not exceed the normal free height.

(*f*) Should the specified free height exceed the normal free height or be less than the required free height or both, the several specified heights are not commensurate.

WORKMANSHIP AND FINISH

Workmanship. 15. Before offering springs for inspection they shall be compressed solid three times. The springs shall be submitted for inspection singly or grouped as may be shown by the drawings and shall conform to the drawings within the tolerances specified in Section 11.

Finish. 16. (*a*) The ends of the bars shall be properly tapered to give when coiled a reasonable square, firm bearing. The points of the bars shall be in approximate contact with the adjacent coil and shall not protrude beyond the outside diameter of the springs.

(*b*) When mutually agreed upon by the manufacturer and purchaser, the end bearing surfaces of the springs shall be ground to produce a uniform bearing of at least three-fourths of the circumference and square with the axis of the helix within $\frac{1}{8}$ in. per foot of free length.

MARKING

Marking. 17. (*a*) The name or brand of the manufacturer, the year and month of manufacture and, if specified, the purchaser's class number shall be legibly stamped on each spring at a place not detrimental to the life of the spring.

(*b*) Any stamping by the inspector shall be so placed as not to be detrimental to the life or service of the spring.

INSPECTION AND REJECTION

Inspection. 18. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the springs ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the springs are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of the material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection.

19. (*a*) If any of the springs representing a group fail to conform to the requirements specified in Section 11, but at least one-half of the springs representing a group do conform to these requirements, each spring of the group shall be tested, and those which conform to the requirements shall be accepted. If more than one-half of the springs representing a group fail to conform to requirements specified in Section 11, the group shall be rejected.

(*b*) Individual springs which, subsequent to inspection at the mills or elsewhere and their acceptance, show defects or imperfections will be rejected and shall be replaced by the manufacturer.

Rehearing.

20. Samples tested in accordance with Section 6, which represent rejected material, shall be held for two weeks from the date of the test report.

Reworking.

21. Springs which fail to conform to the requirements of the physical tests or conform to the specified dimensions may be again submitted after being reworked.

TENTATIVE SPECIFICATIONS
FOR
CHILLED-TREAD CAST-IRON WHEELS[1]

A.S.T.M. Designation: A 46 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

MANUFACTURE

Material. 1. Wheels shall be made of a mixture of such composition that, with good foundry practice and proper annealing, they will have the required chill in the tread, and otherwise meet the requirements of these specifications.

Fracture. 2. The fracture shall show a soft, clean gray iron free from defects such as holes more than $\frac{1}{4}$ in. in diameter containing slag or dirt, or clusters of holes honeycombing the hub, or white iron in the plate or hub.

CHEMICAL PROPERTIES AND TESTS

Chemical Composition. 3. The wheels shall conform to the following requirements as to chemical composition:

	MINIMUM	MAXIMUM
Total carbon, per cent	3.00	....
Combined carbon, per cent	....	0.90
Manganese, per cent	0.50	....
Phosphorus, per cent	....	0.50
Sulfur,[a] per cent	....	0.14

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[a] *Sulfur Content.*—The essential condition of chemical composition of chilled-tread wheels is a balance between sulfur, carbon and manganese, and variation in these constituents must not disturb this relation. If on check analysis, the sulfur is found to be not more than 0.02 per cent greater than that specified, it shall not be considered sufficient cause for the rejection of the wheels, provided that the wheels conform to all physical and inspection requirements and provided that the manganese content is at least three and one-half times the sulfur content. Such failure to conform to the specifications should be called to the attention of the manufacturer and subsequent shipments or lots shall conform to the specifications.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. F. B. Coyle, Secretary of Committee A-3 on Cast Iron, International Nickel Co., 67 Wall St., New York City.

These specifications, when adopted as standard, will supersede the present Standard Specifications for Chilled Cast-Iron Wheels (A.S.T.M. Designation: A 46 – 24), 1927 Book of A.S.T.M. Standards, Part I, p. 432.

Chemical Analyses. 4. Analyses shall be made by the manufacturer from test blocks poured during the day's melt from each cupola from which wheels purchased to these specifications are poured. The percentages of manganese, phosphorus and sulfur shall be determined. The determination of carbon shall also be furnished merely for information. A copy of the analysis shall be furnished the purchaser or his representative on request.

Check Analysis. 5. An analysis may be made by the purchaser from one of the test wheels representing each 100 wheels. The sample for analysis shall be taken from drillings obtained by drilling a hole into the back of the plate of the wheel midway between the flange and the hub. The chemical composition thus determined shall conform to the requirements for manganese, phosphorus and sulfur specified in Section 3.

Chemical Analysis Procedure. 6. Chemical analyses shall be determined in accordance with the Standard Methods of Sampling and Chemical Analysis of Pig and Cast Iron (A.S.T.M. Designation: A 64) of the American Society for Testing Materials.[1]

Shipment of Wheels. 7. The purchaser shall not require the manufacturer to hold all lots of wheels until check analysis can be obtained unless it has been found that the manufacturer's product has not been conforming to these specifications.

PHYSICAL PROPERTIES AND TESTS

Thermal Test. 8. (*a*) In making the thermal test, the wheel shall be laid with the flange downward in the sand with the channelway molded in green sand around the wheel, 4 in. deep and of a width as shown in the following table. The tread of the wheel shall form one side of the channelway, the clean flange forming as much of the bottom as its width will cover. This channelway shall be filled with molten cast iron, which shall be hot enough when poured so that the cast ring, when cold, will be solid and free from wrinkles. The time when pouring ceases shall be noted, and after the time specified in the following table has elapsed, the wheel shall be examined. If a crack develops in the wheel within the time limit specified in the table all wheels bearing that same tape size shall be rejected.

WEIGHT OF WHEEL, LB.	COOLING TIME, MINUTES	WIDTH OF CHANNELWAY, IN.
650	3	2
700	5	2
750	5	3
850	7	3

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 448.

(*b*) The use of a permanent mold for making the thermal test in place of the sand mold described in Paragraph (*a*) is permissible. The permanent mold shall consist of an iron ring and bottom board of such dimensions that the wheel to be tested can be immediately placed in the mold and centered to the required channelway.

(*c*) In order to prevent spitting while pouring, the tread and flange may be covered with a coat of chiller paste. Wheels selected for test which are wet or which have been exposed to snow or frost may be warmed sufficiently to dry them or remove the frost before testing, but under no circumstances shall the thermal test be applied to a wheel that in any part feels warm to the hand.

Drop Test. 9. (*a*) The test wheel shall conform to the drop test requirements given in the following table without breaking in two or more pieces. If the test wheel fails all wheels bearing the same tape size shall be rejected:

Weight of Wheel,		Weight of Tup,		Height of Drop,		Number of Blows
lb.	kg.	lb.	kg.	ft.	m	
650	295	250	113	9	2.75	12
700	317	250	113	10½	3.20	12
750	340	250	113	12	3.65	12
850	385	250	113	13	3.96	12

(*b*) If the test wheel cracks with three blows or less it shall be considered as having failed.

(*c*) *Apparatus.*—The anvil of the drop testing machine shall weigh not less than 1700 lb. (770 kg.) and shall be supported on a foundation of rubble masonry or concrete at least 2 ft. (61 cm.) in depth. The striking face of the tup shall be flat and 9 in. (229 cm.) in diameter. The face of each of the three bosses supporting the wheel under test shall be flat and 5 in. (12.7 cm.) in width. The test wheel shall be so placed on the three supports, with the flange down, that the tup will strike centrally on the hub.

Chill Test. 10. (*a*) After having been subjected to the thermal and drop tests, the test wheels shall be broken so that the chill may be examined at at least four different portions of the wheel. The depth of pure white iron shall conform to the following requirements and the depth of the chill shall not vary more than ¼ in. (6.35 mm.) in the middle of the tread on the different portions measured:

Weight of Wheel,		Maximum Depth,		Minimum Depth,	
lb.	kg.	in.	mm.	in.	mm.
650	295	1	25.5	⅜	9.5
700	317	1 1/16	27	7/16	11.1
750	340	1⅜	28.6	½	12.7
850	385	1⅛	28.6	½	12.7

(*b*) If the test wheel does not conform to the requirements specified, all wheels of the tape size represented by the test wheel shall be rejected.

NOTE.—The physical properties and tests specified cover only 33-in. wheels of the weights listed. Requirements for wheels of other sizes are to be supplied by the committee.

Number of Tests.

11. (*a*) *Sampling.*—When ready for inspection, the wheels shall be arranged in groups, all wheels of the same weight being grouped together, and for each 102 wheels which pass inspection and are ready for shipment, two representative wheels shall be taken, one of which shall be subjected to the thermal test and the other shall be used for the drop test.

(*b*) When ordered in lots of 100 or more of each weight, the manufacturer shall arrange to cast them in sufficient quantity so that at least one test wheel may be taken from the wheels cast each day.

DIMENSIONS, WEIGHT AND DESIGN OF WHEELS

Patterns.

12. Patterns and chillers shall be such that they will produce wheels in accordance with the dimensions shown on drawings furnished by the purchaser.

Dimensions.

13. The normal circumference conforming to the specified diameter shall be measured at a point 1$\frac{23}{32}$ in. (43.65 mm.) from the gaging point on the throat of the flange. When measured on the circumference, wheels shall not vary more than $\frac{5}{16}$ in. above or below the normal size. Each wheel shall be so nearly circular that a true metallic ring, placed on its tread and bearing somewhere on the cone, shall, at no point, be more than $\frac{1}{32}$ in. from the tread. The thickness of the flange shall be determined by a minimum and maximum flange thickness gage which shall be regulated to not more than $\frac{1}{32}$ in. (0.794 mm.) over nor more than $\frac{1}{16}$ in. (1.59 mm.) under the normal flange thickness.

Taping.

14. All wheels shall be taped with a standard design of wheel circumference tape. The wheels shall have the figures 1, 2, 3, 4, and 5 cast on the back plate in $\frac{3}{16}$-in. (4.76 mm.) raised figures, $\frac{3}{4}$ in. in height and $\frac{1}{8}$ in. apart. The figure "3" shall represent normal tape size limited by $\frac{1}{16}$ in. (1.59 mm.) over or under the standard circumference (which for 33 in. (838.2 mm.) wheels will be 103.67 in. ± $\frac{1}{16}$ in. (2633.2 mm. ± 1.59 mm.)). The figure "1" shall represent the smallest diameter, and the figure "5" the largest diameter. When taping a wheel the figure representing the tape size shall be chipped off. Tape sizes shall either be stenciled in plain figures on the plate of the wheel or as may be otherwise designated by the purchaser.

Weights. 15. (*a*) If wheels are ordered in accordance with A.R.A. standard drawings the weights shall be as follows:

Maximum Gross Weight of Car, lb.	Maximum Gross Weight of Car, kg.	Normal Weight of Wheel, lb.	Normal Weight of Wheel, kg.	Minimum Weight of Wheel, lb.	Minimum Weight of Wheel, kg.
103 000	46 700	650	295	640	290
136 000	61 700	700	317	690	313
169 000	76 500	750	340	740	335
210 000	95 250	850	385	835	380

(*b*) In the case of wheels ordered with cores smaller in diameter than the standard, the additional weight shall be considered as additional to the normal weight given in the above table and shall be paid for by the purchaser.

(*c*) In any shipment where the average weight of wheels is above the normal weight given in the above table the excess weight shall be at the expense of the manufacturer.

FINISH

Surface Finish. 16. The body of the wheel shall be free from slag, shrinkage, or blow holes. The tread and throat shall be free from irregular wrinkles, slag, sand wash, chill cracks or sweat. Wheels will not be rejected on account of cracks around the circumference of the center core commonly known as "drawn hubs" or slight shrinkage holes on the face of the hub which will not interfere with the proper mounting of the wheels.

MARKING

Marking. 17. All wheels shall be marked and numbered consecutively in accordance with instructions issued by the purchaser. All wheels shall have plainly cast on the inside plate of the wheel the initials of the purchaser, the wheel number, weight of the wheel, and the month, day and year when cast. No wheels shall have duplicate numbers and all indistinct or duplicate numbers may be corrected only after having received the approval of the inspector. All wheels shall have the name of the manufacturer and the place of manufacture cast on the outside plate of the wheel.

INSPECTION AND REJECTION

Inspection. 18. The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the wheels ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the wheels are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection and Retest.

19. (*a*) Should the test wheel selected for the drop test, thermal test, or chill test fail to conform to the requirements specified, all wheels bearing the same tape size shall be rejected (see Sections 8, 9 and 10). The inspector shall then select another wheel of a different tape size, which shall be submitted to the same test as the wheel which failed and if it passes the requirements of the test the remainder of the lot shall be accepted, provided the requirements of all other tests have been met.

(*b*) The numbers of all wheels which have been rejected because of failure to meet the requirements of the drop test, thermal test, or chill test shall be noted and such wheels shall not be submitted for test at any future time.

(*c*) *Individual Rejection.*—Individual wheels shall be rejected in accordance with the following:

(*1*) If they are under the minimum weight specified;
(*2*) If they have surface defects described in Section 16;
(*3*) If they are under the specified dimensions.

APPENDIX

As information of possible value to the users of these specifications, Committee A-3 on Cast Iron wishes to state that the Association of Manufacturers of Chilled Car Wheels has adopted recommended designs of chilled-tread car wheels of 24, 26, 28, 30, 33, 36, 39 and 42-in. diameter. The designs for the 33-in. diameter single plate wheels were approved in 1928 by the American Railway Association. The wheels for which designs have been made, the standard for maximum load and estimated weight of the wheels are given below:

DIAMETER OF WHEEL, IN.	STANDARD FOR MAXIMUM LOAD PER WHEEL, LB.	ESTIMATED WEIGHT, LB.
24	6 000	320
24	9 000	360
24	12 000	400
24	16 000	440
26	6 000	360
26	9 000	410
26	12 000	460
26	16 000	510
28	6 000	410
28	9 000	460
28	12 000	510
28	16 000	560
30	6 000	485
30	9 000	530
30	12 000	575
30	16 000	615
33	12 875	650
33	17 000	700
33	21 125	750
33	26 250	850
36	16 000	800
36	20 000	860
36	25 000	980
39	16 000	875
39	20 000	950
39	25 000	1100
42	16 000	1000
42	20 000	1075
42	25 000	1225

TENTATIVE SPECIFICATIONS
FOR
GRAY-IRON CASTINGS FOR VALVES, FLANGES AND PIPE FITTINGS[1]

A.S.T.M. Designation: A 126 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision

ISSUED, 1929.

Scope. 1. These specifications cover gray iron for castings such as valve bodies, fittings, flanges, including parts to be assembled into valves, manufactured in advance and supplied for sale from stock by the manufacturer, jobber, or other dealer.

Two classes of castings are included as follows:

Class A.—Regular gray iron.

Class B.—Higher-strength gray iron including the so-called semi-steels used in valves and fittings.

MANUFACTURE

Process. 2. The iron shall be made by the cupola, air furnace, electric furnace, or other approved process. The iron shall be produced under regular chemical and physical control and shall be gray iron of high quality.

CHEMICAL PROPERTIES AND TESTS

Chemical Composition. 3. Drillings taken from test ingots, broken test specimens or from castings shall conform to the following requirements as to chemical composition:

Sulfur	not over 0.12 per cent.
Phosphorus	not over 0.75 per cent.

PHYSICAL PROPERTIES AND TESTS

Tension Test. 4. (*a*) The tension test specimen shall conform to the following requirements as to tensile strength:

Class A, Regular gray iron	not less than 21 000 lb. per sq. in.
Class B, Higher-strength gray iron	not less than 30 000 lb. per sq. in.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. F. B. Coyle, Secretary of Committee A-3 on Cast Iron, International Nickel Co., 67 Wall St., New York City.

(*b*) After reaching a stress of 15,000 lb. per sq. in., the speed of the cross-head of the testing machine shall not exceed $\frac{1}{8}$ in. per minute.

Transverse Test.

5. (*a*) The transverse test shall be optional. When transverse tests are made, the transverse test specimen, when placed horizontally upon supports 12 in. apart and tested under a centrally applied load, shall conform to the following requirements:

	REGULAR GRAY IRON	HIGHER-STRENGTH GRAY IRON
Load at center, lb.	not less than 2500	not less than 3300
Deflection at center, in.	not less than 0.10	not less than 0.12

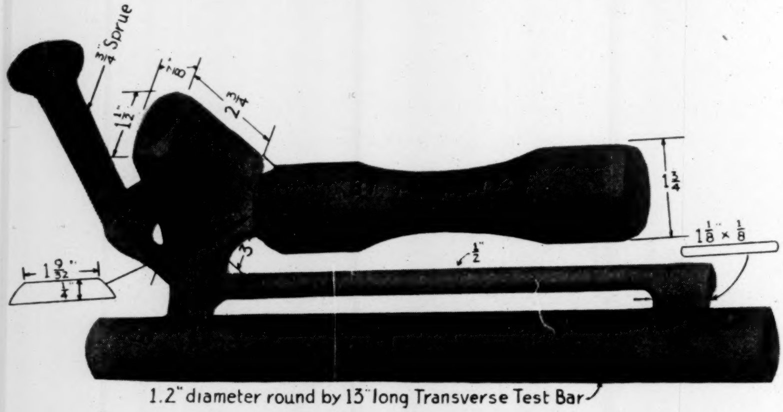

FIG. 1.—Mold of Tension and Transverse Test Specimens.

(*b*) The rate of application of the load shall be such that a central deflection of 0.10 in. is produced in from 20 to 40 seconds.

(*c*) In case the transverse test specimen varies from the specified diameter of 1.20 in., a correction factor conforming to the following shall be applied:

DIAMETER OF TRANSVERSE TEST SPECIMEN, IN.	CORRECTION FACTOR	DIAMETER OF TRANSVERSE TEST SPECIMEN, IN.	CORRECTION FACTOR
1.10	0.770	1.21	1.025
1.11	0.791	1.22	1.051
1.12	0.813	1.23	1.077
1.13	0.835	1.24	1.103
1.14	0.857	1.25	1.130
1.15	0.880	1.26	1.158
1.16	0.903	1.27	1.185
1.17	0.927	1.28	1.214
1.18	0.951	1.29	1.242
1.19	0.975	1.30	1.271
1.20	1.000		

Mold. 6. One mold containing one or more tension test specimens and, when desired, one transverse test specimen, made as indicated in Fig. 1 shall be poured at least twice a day from each heat from which castings are made under these specifications. The molds for these test specimens shall be made from plate pattern, on a standard molding machine if possible, from the same lot of sand and in the same general way as that in which molds for the castings are made. Each specimen shall be marked to show cupola or furnace number, date and hour when the mold is poured by either casting in the mold or stamping the specimens as soon as possible after shaking-out.

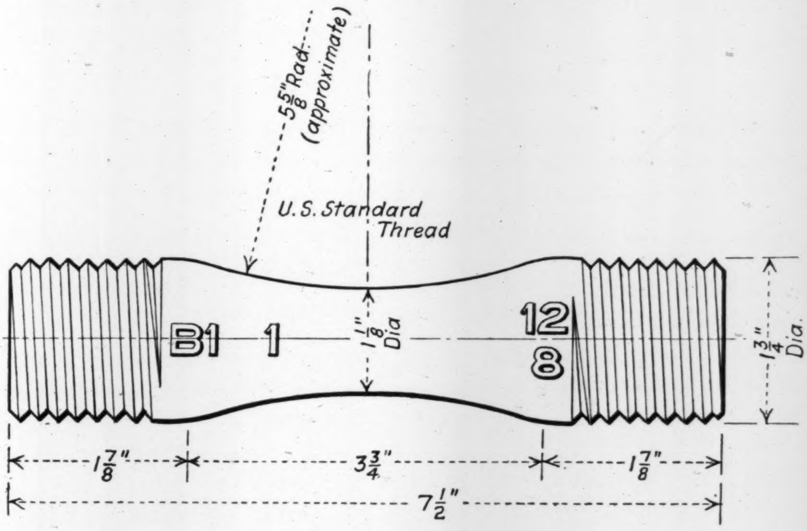

FIG. 2.—Tension Test Specimen.

NOTE.—The numbering shown on the test specimens in Figs. 1 and 2 is intended simply to illustrate a method of designation. In the particular method shown $\frac{12}{8}$ refers to December 8, B1 is the cupola number and the numeral 1 which follows shows the hour cast (1 P. M.).

Test Specimens. 7. Tension test specimens, cast as illustrated in Fig. 1, shall conform to the dimensions shown in Fig. 2, shall be reasonably smooth and round at breaking section and shall be tested without machining except that the enlarged ends shall be threaded ($1\frac{3}{4}$-in. U. S. standard threads are recommended). The cross-sectional area at the breaking section shall be within ±5 per cent of 1 sq. in. and the ultimate stress shall be calculated on the minimum cross-section.

Tension Test Apparatus.

8. Ball and socket specimen holders or spherical-seated bearings or other device which will insure that the specimen, when under load, will be as nearly as possible in pure axial tension without transverse stress shall be used in making the tension test.

NOTE.—Suitable ball and socket specimen holders and spherical-seated bearing devices are shown in Figs. 6 and 8 and described in Section 13 of the Tentative Methods of Tension Testing of Metallic Materials (A.S.T.M. Designation: E 8 - 27 T) of the American Society for Testing Materials.[1]

Records.

9. Records of the chemical composition of the iron and physical properties of the test specimens shall be systematically made and maintained.

WORKMANSHIP AND FINISH

Workmanship and Finish.

10. The castings shall be sound, clean, free from sand, of workmanlike finish and soft enough to machine well.

CERTIFICATION

Certification.

11. Upon request of the purchaser, the manufacturer shall be prepared to certify that his product conforms to the requirements of these specifications.

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[1] *Proceedings*, Am. Soc. Testing Mats. Vol. 27, Part I, p. 1067 (1927); also 1929 Book of A.S.T.M. Tentative Standards, p. 775.

TENTATIVE SPECIFICATIONS

FOR

ZINC (HOT-GALVANIZED) COATINGS ON STRUCTURAL STEEL SHAPES, PLATES AND BARS AND THEIR PRODUCTS[1]

A.S.T.M. Designation: A 123 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1928; REVISED, 1929.

Scope.

1. These specifications cover the protective zinc coatings, applied on structural steel shapes, plates and bars and their products (Note 1) by dipping the articles in a molten bath of zinc (Note 2).

NOTE.—These specifications presuppose the use of steel of recognized standard manufacture conforming to standard specifications.

CHEMICAL PROPERTIES

Slab Zinc.

2. The slab zinc used for the coating shall conform to the requirements of the Standard Specifications for Slab Zinc (Spelter) (A.S.T.M. Designation: B 6) of the American Society for Testing Materials,[2] and shall be at least equal to the grade designated as "Prime Western."

Chemical Composition.

3. (*a*) The impurities contained in the molten zinc bath during actual operation as shown by ladle analysis shall not exceed the following:

Lead	1.60 per cent
Iron	0.08 "
Aluminum	0.01 "

Samples for Chemical Analysis.

4. (*a*) Analysis of the ladle tests shall be based on the combined borings from not less than three samples taken on the center line of the pot. One sample shall be taken midway of the pot and the other two at opposite ends, but not nearer the ends than one-half the width of the pot. The samples shall be taken from a depth of at least 2 in below the surface of the zinc but not greater than 25 per cent of the depth of the zinc.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. J. A. Capp, Chairman of Sectional Committee on Zinc Coating of Iron and Steel, functioning under the procedure of the American Standards Association, Testing Laboratory, General Electric Co., Schenectady, N. Y.

[2] 1927 Book of A.S.T.M. Standards, Part I, p. 524.

(*b*) The implements and molds used to obtain the samples shall be of such materials as shall not change the proportions of lead, iron or aluminum in the zinc sample.

PHYSICAL PROPERTIES AND TESTS

Steel Embrittlement. 5. In so far as possible the processes of pickling and zinc coating shall not cause embrittlement of the base material nor change its physical or chemical characteristics (Note 3).

Weight of Coating. 6. The weight of the zinc coating per square foot of actual surface shall not average less than 2.0 oz., and no individual specimen shall show less than 1.8 oz.

Test Specimens. 7. (*a*) Test specimens shall be selected from the material being galvanized and shall be galvanized at the same time, in the same manner and in the same pot as the material whose coating characteristics they are intended to indicate. If the lot of material is of inconvenient lengths, pieces of the same shape but of convenient lengths for handling (at least three feet long) may be substituted as test specimens (Note 4).

(*b*) Three specimens may be required as needed for carrying out, as described in Section 13 (*b*), the determination of the weight of coating on material galvanized in one shift.

(*c*) No test specimen shall be used for the determination of the weight of coating which would fail to conform to other requirements of these specifications as described in Sections 10 and 13 (*a*).

Procedure. 8. The weight of the zinc coating shall be determined by weighing one or more specimens after pickling and drying and again after coating. In the case of material manufactured without inspection, the weight of coating may be determined by stripping an entire piece in accordance with the Standard Methods of Determining Weight of Coating on Zinc-Coated Articles (A.S.T.M. Designation: A 90) of the American Society for Testing Materials.[1]

Uniformity of Coating. 9. In the absence of a practicable test to determine the uniformity of coating on structural materials the uniformity of the zinc coating shall be determined by visual inspection in accordance with Section 10.

WORKMANSHIP AND FINISH

Finish and Adherence. 10. The zinc coating shall be adherent, smooth, continuous and thorough. It shall be free from such imperfections as lumps, blisters, gritty areas, uncoated spots, acid and black spots, dross (Note 5) and flux. The coating shall not be so loosely adherent as to be removable by any reasonable process of handling and erection. Light blows with a $\frac{1}{2}$-lb. hammer shall not cause peeling of the coating adjacent to the area deformed by the hammer blow. The coating shall not interfere with the intended use of the material.

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[1] 1927 Book of A.S.T.M. Standards. Part I. p. 343.

Handling. 11. After immersion in the molten zinc, the structural shapes, plates or bars shall not be subjected to any process of scraping or wiping which will reduce the uniformity or the specified weight of the zinc coating.

INSPECTION AND REJECTION

Inspection. 12. (*a*) The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the coating is being furnished in accordance with these specifications.

(*b*) The material shall be inspected at the manufacturer's plant during the process of manufacture. However, by agreement the purchaser may make the tests which govern the acceptance or rejection of the materials in his own laboratory or elsewhere; such tests shall be made at the expense of the purchaser. The cost of analyzing samples of the zinc bath in accordance with Section 4 (*a*) shall be paid by the purchaser.

Rejection. 13. (*a*) Visual inspection of materials ready for shipment shall be made to determine conformity with the requirements of Section 10; when partial inspection warrants rejection of a lot, the manufacturer may re-sort the lot and submit it once again for inspection.

(*b*) Where tested in accordance with Sections 7 and 8, if one specimen should fail to conform to the requirements specified in Section 6 for the weight of coating, a second and third specimen shall be tested. Failure of either the second or third specimen to conform to the requirements shall be cause for rejection of the lot which the samples represent.

(*c*) Materials that have been rejected may be stripped and regalvanized and again submitted for test and inspection when they shall conform to the requirements of these specifications.

EXPLANATORY NOTES

NOTE 1.—The use of the word "products" is not meant to imply an unqualified indorsement of the indiscriminate practice of applying zinc coatings on assembled parts.

NOTE 2.—The zinc coating on the materials covered by these specifications is too heavy to permit bending and other severe fabrication of the galvanized article without seriously damaging the coating.

NOTE 3.—In isolated cases steels are encountered which are susceptible to embrittlement by the normal hot-dip galvanizing processes. Such embrittlement may depend on the chemical composition of the steel or a process of cold working the material in fabrication. Proper heat treatment or other means to correct embrittlement should be covered by separate contract between the purchaser and the manufacturer.

NOTE 4.—The use of convenient lengths of material for test specimens should not be interpreted to mean that small pieces of flat plate or odd shapes can be substituted for test specimens. Practice has shown that coupon specimens do not give true indications of the weight of coating on the shapes.

NOTE 5.—It is highly desirable to keep the materials being coated from coming in contact with the dross, and in all cases where practicable such contact should be avoided. Every practice tending to agitate the dross should be avoided.

TENTATIVE DEFINITIONS OF TERMS, WITH UNITS AND SYMBOLS, RELATING TO MAGNETIC TESTING[1]

A.S.T.M. Designation: A 127 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

In the following list of definitions the term defined is given first followed in parenthesis by any optional alternative terms which may be used when the context clearly indicates the intended conception. The symbol for the quantity is then given wherever such symbol is in use, followed by the definition of the standard term.

The name of the unit employed is included, together with the definition of the unit.

A. Basic Conceptions

Magnetic Field (*Field*).—The region in space in which a magnetic state exists.

UNIT: None.

Magnetic Flux (*Flux*), Φ.—The magnetic quantity which by its variation is capable of producing in an associated electric circuit an electromotive force proportional to its time rate of variation.

UNIT: *Maxwell.*—The maximum value of the magnetic flux, the uniform variation of which between zero and its full value in one second induces one c.g.s. unit of electromotive force in a single turn electric circuit enclosing the flux.

Magnetomotive Force, $\mathcal{F}$.—The total magnetizing influence acting on any part of a magnetic circuit.

UNIT: *Gilbert.*—The magnetomotive force resulting from a current in an electric circuit of any number of turns linked with the magnetic circuit when the product of the current in amperes by the number of turns is $\frac{1}{0.4\pi}$.

NOTE.—When a current of I amperes is flowing in a circuit of N turns, $\mathcal{F} = 0.4\,\pi\,N\,I$.

Magnetic Force (*Magnetizing Force, Field Intensity*), H.—The space rate of variation of magnetomotive force at any point in the magnetic circuit.

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[1] Criticisms of these Tentative Definitions are solicited and should be directed to Mr. R. L. Sanford, Secretary of Committee A-6 on Magnetic Properties, U. S. Bureau of Standards, Washington, D. C.

UNIT: *Gilbert per centimeter.*—The magnetic force when the magnetomotive force varies at the rate of one gilbert per centimeter.

NOTE.—At the center of an infinitely long solenoid having n turns per centimeter in which a current of I amperes is flowing, $H = 0.4 \pi n I$.

B. *Derived Conceptions*

Induction (*Flux Density*), *B*.—The flux per unit area normal to the direction of the induction.

UNIT: *Gauss.*—An induction of one Maxwell per square centimeter.

Normal Induction, *B*.—The induction in a magnetic material corresponding to a given magnetic force when the material is in a symmetrically cyclic magnetic condition with respect to the given magnetic force.

UNIT: Same as for *Induction.*

Intrinsic Induction (*Ferric Induction*), B_i.—The excess of the normal induction over that corresponding to the same magnetic force in empty space.

UNIT: Same as for *Induction.*

Saturation Induction, B_s.—The maximum intrinsic induction possible in a material.

UNIT: Same as for *Induction.*

Permeability, μ.—When used without a qualifying adjective, understood to be the normal permeability as defined below.

UNIT: None.

Normal Permeability, μ.—The ratio of the normal induction to the corresponding magnetic force.

UNIT: None.

Initial Permeability, μ_0.—The normal permeability when both the magnetic force and the induction are vanishingly small.

UNIT: None.

Differential Permeability, μ_d.—The ratio of the positive increase of normal induction to the positive increase of magnetic force when these increases are vanishingly small.

UNIT: None.

Incremental Permeability, μ_Δ.—The ratio of the cyclic change in induction to the corresponding cyclic change in magnetic force when the mean induction differs from zero.

UNIT: None.

Reversible Permeability, μ_r.—The incremental permeability when the change in induction is vanishingly small.

UNIT: None.

Intrinsic Permeability, μ_i.—The ratio of the intrinsic induction to the corresponding magnetic force.

UNIT: None.

Permeance, $\mathcal{P}$.—The property of any part of a magnetic circuit which determines the flux corresponding to a given magnetomotive force.

NOTE.—Permeance $= \frac{\Phi}{\mathcal{F}}$ equivalent to $\frac{\mu A}{l}$ for uniform μ.

where μ = permeability;
A = area in square centimeters; and
l = length in centimeters.

UNIT: None.

Reluctivity.—The reciprocal of permeability.

UNIT: None.

Reluctance, $\mathcal{R}$.—The reciprocal of permeance.

NOTE.—Reluctance $= \frac{\mathcal{F}}{\Phi} = \frac{l}{\mu A}$ for uniform μ.

UNIT: *Oersted*.

Remanence.—The magnetic induction which remains in a magnetic circuit after the removal of an applied magnetic force.

NOTE.—If there is an air gap in the magnetic circuit, the remanence will be less than the residual induction.

UNIT: Same as for *Induction*.

Residual Induction, B_r.—The magnetic induction which remains in a magnetic material when the effective magnetic force has been reduced to zero.

NOTE.—When the material is in a symmetrically cyclic magnetic condition, the residual induction is called the *normal* residual induction.

UNIT: Same as for *Induction*.

Retentivity.—The property of a material measured by the normal residual induction remaining after the removal of an applied magnetic force corresponding to the saturation induction for the material.

UNIT: Same as for *Induction*.

Coercive Force, H_c.—The reversed magnetic force that is just sufficient to reduce the residual induction in a material to zero.

NOTE.—When the residual induction is the *normal* residual induction, the coercive force required is called the *normal* coercive force.

UNIT: Same as for *Magnetic Force.*

Coercivity.—The property of a material measured by the coercive force required to reduce to zero the induction remaining after the removal of an applied magnetic force corresponding to the saturation induction for the material.

UNIT: Same as for *Magnetic Force.*

Core Loss (*Iron Loss*), W.—The power expended in a magnetic material subjected to a varying induction.

Eddy Current Loss, W_e.—The part of the core loss due to currents circulating in the magnetic material as a result of electromotive forces induced by the varying induction.

Hysteresis Loss, W_h.—That part of the core loss due to so-called hysteresis effects.

Standard Core Loss, $W_{B/f}$.—The total power in watts per kilogram expended in the magnetic material which is subjected to a harmonically varying induction of a specified maximum value B and of a specified frequency f.

Aging (of magnetic materials).—The normal or accelerated change in magnetic properties of a magnetic material under continued normal or specified artificial aging conditions. When used in reference to core loss this term, unless otherwise modified, implies an increase in loss. When used in reference to permeability or remanence the term, in a positive sense, indicates a decrease in these quantities.

TENTATIVE METHODS OF CHEMICAL ANALYSIS OF METALLIC MATERIALS FOR ELECTRICAL HEATING[1]

A.S.T.M. Designation: B 71 – 29 T

This is a Tentative Standard, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

Issued, 1927; Revised, 1928, 1929.

DETERMINATION OF NICKEL

Solutions Required

Concentrated Sulfuric Acid (sp. gr. 1.84).

Concentrated Nitric Acid (sp. gr. 1.42).

Concentrated Hydrochloric Acid (sp. gr. 1.19).

Dilute Sulfuric Acid (1:1).—Slowly stir 100 cc. of H_2SO_4 (sp. gr. 1.84) into 100 cc. of water.

Dilute Sulfuric Acid (1:99).—Slowly stir 10 cc. of H_2SO_4 (sp. gr. 1.84) into 990 cc. of water.

Tartaric Acid (20-per-cent).

Ammonium Hydroxide (sp. gr. 0.90).

Dilute Acetic Acid (1:3).—Mix 1 cc. of acetic acid (sp. gr. 1.04) and 3 cc. of water.

Nitro-Hydrochloric Acid.—Mix 10 cc. of concentrated HNO_3 (sp. gr. 1.42), 30 cc. of concentrated HCl (sp. gr. 1.19) and 40 cc. of water.

Ammonium Bisulfite.—Dissolve 1 g. of ammonium bisulfite in 5 cc. of hot water.

Sodium Dimethylglyoxime.—Dissolve 3 g. of dimethylglyoxime in 100 cc. of NaOH (3-per-cent), made fresh each time used.

Method

Dissolve exactly 1 g. of the alloy sample in 20 cc. of nitro-hydrochloric acid in a covered 600-cc. beaker. Add 20 cc. of dilute H_2SO_4

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. F. E. Bash, Secretary of Committee B-4 on High-Temperature and Electrical-Resistance Alloys, Technical Department, Driver-Harris Co., Harrison, N. J.

(1:1) and evaporate the liquid carefully to fumes of sulfur trioxide. When the beaker and its contents have cooled, add 100 cc. of water and allow the solution to digest at a low heat until all salts have dissolved. Filter the solution on a 9-cm. paper to remove any silica, and wash the paper and residue thoroughly with hot water or, if an insoluble residue is present, wash with dilute H_2SO_4 (1:99). Ignite the precipitate at a low heat, and treat with 2 cc. of HF, and several drops of concentrated H_2SO_4 in a platinum crucible, and evaporate to dryness. Fuse the residue with a little sodium carbonate, dissolve in HCl and add to the main nickel solution.

Transfer the nickel solution to a 250-cc. graduated flask, and dilute to the mark with cold water. Mix and draw off exactly 50 cc. by means of an accurately calibrated pipette, and transfer this aliquot portion to a 600-cc. beaker. This aliquot portion represents 0.2 g. of the original sample. Add 25 cc. of a 20-per-cent solution of tartaric acid (enough to hold all the iron and chromium in solution), make the solution alkaline with NH_4OH, and then make it acid with an excess of 15 cc. of concentrated HCl (sp. gr. 1.19). Add 35 cc. of a *freshly prepared* solution of sodium dimethylglyoxime, and make the solution ammoniacal, and then make it just acid with dilute acetic acid (1:3). Stir the solution vigorously and allow it to stand at a temperature of from 75 to 90° C., with occasional stirring, for one hour. If an alcoholic solution of dimethylglyoxime was used to precipitate the nickel, the contents of the beaker should be digested at a temperature just short of the boiling point until the odor of alcohol can no longer be detected.

Filter the scarlet precipitate of nickel dimethylglyoxime on a tared Gooch crucible. Wash thoroughly with hot water and dry at 110° C. to constant weight. Cool in a desiccator and weigh. The weight of nickel dimethylglyoxime multiplied by 20.32 and again by 5 gives the percentage of nickel in the sample. This method yields results that are correct within ± 0.35 per cent.

If greater accuracy is desired, use a larger aliquot portion with proportionally larger amounts of reagents and filter the nickel dimethylglyoxime precipitate on an 11-cm. paper and wash thoroughly 18 or 20 times with hot water. Return the paper and precipitate to the 600-cc. beaker, treat with 5 cc. of concentrated H_2SO_4 (sp. gr. 1.84) and 25 cc. of concentrated HNO_3 (sp. gr. 1.42) and boil the liquid gently until strong fumes of sulfur trioxide are evolved.

Having allowed the beaker and its contents to cool somewhat, add 10 cc. of concentrated HNO_3 (sp. gr. 1.42) and repeat the evaporation. Rinse the cover and sides of the beaker with a fine jet of water and fume the solution again to insure the expulsion of every trace of the HNO_3. When cool, add approximately 50 cc. of cold water and boil the contents of the beaker for several minutes, which should result in a perfectly clear solution.

Neutralize with NH_4OH and add an excess of 20 cc. NH_4OH (sp. gr. 0.90). Add 1 g. of ammonium bisulfite dissolved in 5 cc. of hot water. Now electrolize the nickel sulfate solution with a current of from 1 to 2 amperes, using a platinum-gauze weighed cathode and a spiral platinum anode. Continue the electrolysis until the solution has become colorless, and then continue for at least 15 minutes longer. Now test the solution by adding 1 or 2 drops of it to a solution of potassium sulfocarbonate. Pink color indicates the presence of nickel. The amount of the solution withdrawn for this test will not affect the results and may be neglected. This test will show whether or not the electrolysis has been completed. Wash the metal deposited on the cathode with water. Remove the cathode and dip it first into a beaker of distilled water and then into absolute alcohol, dry for a few minutes at a temperature of 80 to 100° C., and weigh. The increase in weight of the cathode multiplied by 100 and divided by the weight of the sample taken gives the percentage of nickel in the sample.

Accuracy.—In the case of a nickel content of 60 to 80 per cent, duplicate determinations should check within ± 0.35 per cent nickel by the gravimetric method and ± 0.15 per cent nickel by the electrolytic method.

DETERMINATION OF CHROMIUM
BY THE
PERSULFATE METHOD

SOLUTIONS REQUIRED

Silver Nitrate Solution (0.5-per-cent).—Dissolve 5 g. of $AgNO_3$ in 1000 cc. of water.

Ammonium Persulfate (15-per-cent).—Dissolve 15 g. of the salt in 100 cc. of water. (The solution should be kept in a cool place and should not be used if over three days old. A fresh solution is preferable).

Sodium Chloride (10-per-cent).—Dissolve 100 g. of NaCl in 1000 cc. of water.

Nitro-Hydrochloric Acid.—Mix 30 cc. of concentrated HCl (sp. gr. 1.19), 10 cc. of concentrated HNO_3 (sp. gr. 1.42), and 40 cc. of water.

Sulfuric Acid (1:1).—Slowly stir 500 cc. of concentrated H_2SO_4 (sp. gr. 1.84) into 500 cc. of water.

Standardized Ferrous Ammonium Sulfate Solution.—Dissolve 39.25 g. of ferrous ammonium sulfate in distilled water, add 20 cc. of dilute H_2SO_4 (1 : 1), dilute to 1 liter, mix thoroughly and standardize against 0.1 *N* potassium permanganate, which has in turn been standardized against the U. S. Bureau of Standards Sodium Oxalate. This solution should be standardized just before using, as its value may change from day to day. One cubic centimeter of 0.1 *N*. solution equals 0.001733 g. of chromium.

Standard Potassium Permanganate Solution (0.1 N).—Dissolve approximately 3.18 g. of pure potassium permanganate in 300 cc. of hot distilled water, boil for 10 to 15 minutes, cool to room temperature, and filter on asbestos. Transfer the solution to a glass-stoppered bottle and allow it to stand for two weeks, at the end of which time filter again on asbestos and transfer to a liter flask and dilute to the mark. This solution should be kept in a dark bottle. After a preliminary standardization against the U. S. Bureau of Standards Sodium Oxalate dilute so as to be exactly 0.1 *N*, and verify this strength by a second comparison with sodium oxalate.

METHOD

Treat approximately 0.2000 g. of the sample in a 500-cc. flask with 20 cc. of nitro-hydrochloric acid and 0.5 cc. of HF (48-per-cent), warm at a moderate temperature (about 60° C.) until the reaction is complete. Add 20 cc. of dilute H_2SO_4 (1 : 1), 50 cc. of water, and evaporate just to fumes of sulfuric acid. If any salts separate out, redissolve by adding 250 cc. of water and digest on a hot plate until an entirely clear solution results. Remove from the plate and add 1 cc. of $AgNO_3$ solution (0.5-per-cent), and sufficient ammonium persulfate (approximately 15 cc. for 10 to 12-per-cent chromium alloys and 25 cc. for 20-per-cent chromium alloy) to thoroughly oxidize the manganese, and boil for 3 minutes. Add 20 cc. of NaCl solution (10-per-cent), heat on a plate until the manganese dioxide has dissolved completely and boil for five minutes. Cool to room temperature, and add from a burette standardized ferrous ammonium sulfate until the solution turns green, and then add 5 cc. in excess. Titrate this excess back with 0.1 *N* potassium permanganate.

Calculate the percentage of chromium from the following formula:

$$\text{Percentage of Chromium} = \frac{[(A \times B) - C] \times 0.001733}{0.2, \text{ or weight of sample}} \times 100$$

where A = volume in cubic centimeters of ferrous ammonium sulfate used;

B = normality factor of ferrous ammonium sulfate, determined daily;

C = volume in cubic centimeters of 0.1 N potassium permanganate used.

Accuracy.—In the case of a chromium content of 10 to 20 per cent, duplicate determinations should check within ±0.15 per cent chromium.

DETERMINATION OF IRON
BY THE
CUPFERRON METHOD

SOLUTIONS REQUIRED

Dilute Hydrochloric Acid (1:1).—Mix equal parts of concentrated HCl (sp. gr. 1.19) and water.

Dilute Hydrochloric Acid (1:19).—Mix 5 cc. of concentrated HCl (sp. gr. 1.19) and 95 cc. of water.

Dilute Ammonium Hydroxide (1:19).—Mix 1 cc. of NH_4OH (sp. gr. 0.90) and 19 cc. of water.

Dilute Sulfuric Acid (1:4).—Slowly stir 1 cc. of concentrated H_2SO_4 (sp. gr. 1.84) into 4 cc. of water.

Dilute Sulfuric Acid (1:9).—Slowly stir 1 cc. of concentrated H_2SO_4 (sp. gr. 1.84) into 9 cc. of water.

Stannous Chloride Solution.—Dissolve 50 g. of stannous chloride in 100 cc. of concentrated HCl (sp. gr. 1.19) and dilute to 1000 cc.

Cupferron (6-per-cent).—Freshly prepared filtered cupferron ($C_6H_5(NO)ONH_4$).

METHOD

For alloys containing 10 per cent or more of iron, use a 1-g. sample, and for alloys containing 2 per cent or less of iron use a 5-g. sample. Dissolve the sample in a 400-cc. covered beaker in 25 to 75 cc. of concentrated HCl (sp. gr. 1.19) at a temperature of about 65° C. Add 2 cc. of concentrated HNO_3 (sp. gr. 1.42), and from 20 to 25 cc. of concentrated H_2SO_4 (sp. gr. 1.84), and evaporate the solution until fumes of sulfur trioxide are given off. After having allowed the beaker and its contents to partly cool, add 50 cc. of warm water and boil the solution for several minutes to dissolve all salts. Filter the liquid on an 11-cm. paper containing some paper pulp, and wash the residue and filter thoroughly with warm water. Reserve the filtrate. Ignite any residue in a platinum crucible until the carbon of the filter paper has burned off. After allowing the crucible to cool, add one or two drops of concentrated H_2SO_4 (sp. gr. 1.84) and several cubic centimeters of HF and evaporate the solution to dryness. Any remaining residue is fused with a few grams of sodium carbonate. Dissolve the fusion in dilute HCl (1:1) and boil to expel carbon dioxide. Add a slight excess of dilute NH_4OH (1:19) and boil the solution for several minutes. Filter, and wash well with hot water. Dissolve the precipitate off of the filter in 20 cc. of hot dilute H_2SO_4 (1:4) and add it to the main filtrate which should have a total volume of not more than 150 cc. Cool the solution to about 15° C., treat with a slight excess of cold, freshly prepared solution of cupferron (6-per-cent), which should cause the complete precipitation of the iron while all the nickel and chromium should remain in solution. A brownish-red, partly amorphous, partly crystallin precipitate should separate out.

As soon as a drop of the reagent causes the formation of a transient snow-white crystallin precipitate, all of the iron is down. Add some ashless paper pulp, and filter the contents of the beaker on an 11-cm. paper, wash the precipitate 18 to 20 times with cold dilute H_2SO_4 (1:9) and finally wash 5 or 6 times with cold dilute NH_4OH (1:19). Discard the filtrate. This ammonia wash dissolves out the excess of cupferron, and will also dissolve any vanadium that might be present.

Ignite the cupferron precipitate, first at a low-red heat and finally at 900 to 1000° C. Transfer the iron oxide to a 150-cc. covered beaker and wash the crucible with 20 cc. of hot HCl (1:1). Add 10 cc. of concentrated HCl (sp. gr. 1.19) and digest the solution at a temperature somewhat short of boiling. Add stannous chloride solution from time to time in amounts sufficient to discharge the yellow color of the ferric chloride, and to provide a few drops in excess. Finish the determination by the Reinhardt-Zimmerman method.

Accuracy.—In the case of an iron content of 0.5 per cent, duplicate determinations should check within ± 0.05 per cent iron.

In the case of an iron content of 25 per cent, duplicate determinations should check within ± 0.2 per cent iron.

DETERMINATION OF MANGANESE

SOLUTIONS REQUIRED

Nitro-Hydrochloric Acid.—Mix 10 cc. of concentrated HNO_3 (sp. gr. 1.42), 30 cc. concentrated HCl (sp. gr. 1.19) and 40 cc. of water.

Concentrated Nitric Acid (sp. gr. 1.42).

Dilute Nitric Acid (1:200).—Mix 1 cc. of concentrated HNO_3 (sp. gr. 1.42) and 200 cc. of water.

Dilute Sulfuric Acid (1:3).—Slowly stir 1 cc. of concentrated H_2SO_4 (sp. gr. 1.84) into 3 cc. of water.

Standardized Ferrous Ammonium Sulfate Solution.—See the Determination of Chromium by the Persulfate Method.

NOTE.—One cubic centimeter of exactly 0.1 *N* solution equals 0.002769 g. of manganese.

Standard Potassium Permanganate Solution (0.1 N).—See the Determination of Chromium by the Persulfate Method.

METHOD

Dissolve exactly 2.000 g. of drillings in a 400-cc. beaker with 40 cc. of nitro-hydrochloric acid, and when in solution evaporate to a syrupy consistency and take up with 50 cc. of concentrated HNO_3 (sp. gr. 1.42). Evaporate this again and add 100 cc. of concentrated HNO_3 and boil down to 80 cc. Add slowly, 5.5 g. at a time, about 3 g. of potassium chlorate. Boil for at least 5 minutes after the last addition of potassium chlorate to insure complete oxidation of the chromium. Add 100 cc. of water and filter through a thin asbestos pad with suction, washing the beaker and pad thoroughly with dilute HNO_3 (1:200), leaving no trace of oxidized chromium. Transfer the pad and the precipitate into the original beaker, being sure to wash out all precipitate adhering to the sides of the funnel with cold water.

Now add 100 cc. of distilled water, 50 cc. of dilute H_2SO_4 (1:3), and 5 cc. in excess of enough ferrous ammonium sulfate to dissolve all of the manganese dioxide. (About 20 cc. should be required for the weight of alloy taken). The normality factor of the ferrous ammonium sulfate must be determined just before using. Stir until all the manganese dioxide is dissolved, and titrate the excess of ferrous ammonium sulfate with 0.1 *N* potassium permanganate. Occluded oxidized chromium is usually the cause for high manganese results.

Calculate the percentage of manganese from the following formula:

$$\text{Percentage of Manganese} = \frac{[(A \times B) - C] \times 0.002769}{2\text{, or weight of sample}} \times 100$$

where A = volume in cubic centimeters of ferrous ammonium sulfate used;

B = normality factor of ferrous ammonium sulfate, determined daily;

C = volume in cubic centimeters of exactly 0.1 *N* potassium permanganate used.

Accuracy.—In the case of a manganese content of 2 to 3 per cent, duplicate determinations should check within ±0.1 per cent manganese.

DETERMINATION OF CARBON
BY THE
VOLUMETRIC METHOD

This method for the determination of carbon is the method for determining carbon by absorption of the carbon dioxide in barium hydroxide solution. Reference should be made to the Determination of Carbon by the Direct-Combustion Method as described in the Standard Methods of Chemical Analysis of Plain Carbon Steel (A.S.T.M. Designation: A 33) of the American Society for Testing Materials.[1]

In a laboratory where accurate results are being obtained by the gravimetric method, or where a large number of samples are to be analyzed, and good weighing methods are in use, the gravimetric method may be used as described in method (*a*) of the Determination of Carbon by the Direct-Combustion Method described in Methods A 33.[2] Where only occasional samples are to be run, it is probable that the volumetric method will give more satisfactory results.

SAMPLE

The sample should weigh at least 4 g. and should be rather finely divided in order that such a large sample may be placed in the combustion boat. Ordinary turnings are satisfactory, except that they are bulky. Usual precautions should be used in obtaining a perfectly clean sample.

APPARATUS

Boats and Lining Material.—Zirkite boats 100 mm. long, 13 mm. wide, and 8 mm. deep (inside dimensions) are most satisfactory, although alundum or porcelain boats may be used. The boats should be ignited in a muffle furnace before using. The bottom of the boat should be lined with a trench of 40-mesh high-grade chrome ore, ignited at 1000° C. and preserved in a glass-stoppered bottle. The sample should be covered with a very thin layer of alundum. Some alundum powder should be sprinkled inside the combustion tube to prevent the boat from sticking.

Flux.—Exactly 2 g. of fine drillings of ingot iron of known carbon content should be sprinkled over the sample before the alundum is placed over the top of the whole charge. The purpose of the ingot iron is not to flux the sample, but is a source of additional heat due to its rapid combustion when the oxygen is turned on. The results

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 276.

[2] *Ibid*, p. 278.

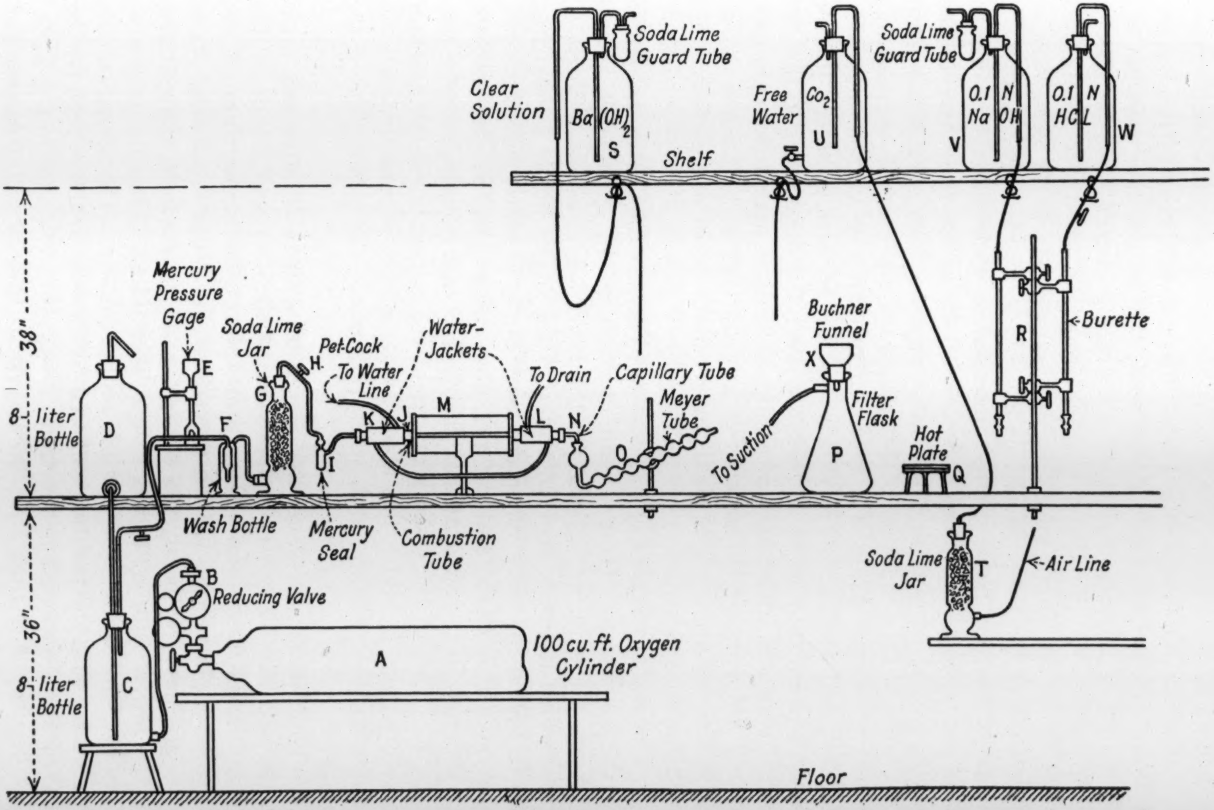

Soda Lime
Guard Tube
Clear
Solution
Ba(OH)2
S
Shelf
Free
Water
Co2
U
Soda Lime
Guard Tube
0.1 N
Na OH
V
0.1 N
HCL
W
Burette
R
38"
36"
8-liter
Bottle
D
Mercury
Pressure
Gage
E
F
Soda Lime
Jar
G
Pet-Cock
H
To Water
Line
K
J
Water-
Jackets
M
To Drain
L
N
Capillary Tube
Meyer
Tube
O
Buchner
Funnel
X
Filter
Flask
P
To Suction
Hot
Plate
Q
Wash Bottle
Mercury
Seal
I
Combustion
Tube
Soda Lime
Jar
T
Air Line
B
Reducing Valve
A
100 cu. ft. Oxygen
Cylinder
8-liter
Bottle
C
Floor

FIG. 1.—Apparatus for the Determination of Carbon by the Volumetric Method.

must be corrected for the amount of carbon added through the use of ingot iron.

Furnace and Combustion Tube.—The standard electric combustion furnace in common use may be used, but as the temperatures are considerably higher, the life of the heating element will be shorter than usual. A pyrometer should always be used. A fused-silica tube 24 in. in length and 1 in. in diameter gives the best results. The ends of the tubes should be encased in water-cooled jackets, or strips of blotting paper partly immersed in water should be placed over the ends of the tubes. At least 8 in. of the tube next to the absorption apparatus is filled with asbestos fiber which has been saturated with a solution of ferric nitrate and heated overnight at 1000° C. Ferric oxide will serve to oxidize any carbon monoxide formed, and will convert any sulfur dioxide to ferric sulfate. In case a combustion tube 30 in. in length is used, the dead space in the end next to the absorption apparatus should be filled with a glass plunger, which will decrease the amount of gas that has to be flushed out at each determination. The glass plunger may consist of a glass cylinder with the ends closed.

Detailed Description of Apparatus.—Figure 1 illustrates the details of the apparatus. Oxygen from the 100 cu. ft. cylinder *A*, passes through the reducing valve *B*, to the lower 8-liter-capacity bottle *C*, from which it forces distilled water to the upper bottle *D*, which is 2.5 ft. higher than *C*. When the lower bottle is nearly full of oxygen, the valve *B* is closed and the gas, now under reduced pressure, can be supplied to the apparatus at the desired rate by means of the petcock *H*. One of the essential parts of the apparatus is the mercury pressure gage *E*, which has a 6-in. scale with $\frac{1}{8}$-in. subdivisions, for indicating the *pressure*, and, when calibrated, the *rate of flow* of the oxygen.

To calibrate the gage, the Meyer tube *O*, is filled to the usual point and the oxygen is regulated until the mercury stands at the desired mark, say $1\frac{1}{8}$ in. The volume of oxygen passing through the apparatus per minute is then determined by collecting it over water in a graduated cylinder, the connection being made to the exit end of the Meyer tube by means of a rubber tube. The rate of flow at 1-in. pressure should be about 100 cc. per minute, although, of course, this varies with the resistance offered to the flow of the oxygen by the reagents and materials in the train.

The capillary tube *N*, in the stopper at the exit of the combustion tube *J*, is an essential part of the apparatus. The size of the capillary opening is adjusted by heating in a flame so that when the mercury gage indicates a certain definite pressure (about 1 in.), the rate of flow through the capillary, the Meyer tube, *O*, being filled and connected, closely approximates but does not exceed 100 cc. per minute. If the rate of flow much exceeds 100 cc. per minute some carbon dioxide will be swept through the barium hydroxide without being absorbed, while if it is much less than 100 cc. all of the carbon dioxide will not be flushed out of the combustion tube in the specified time. Removal of any carbon dioxide in the oxygen is effected by passage through NaOH solution (sp. gr. 1.27) contained in the wash bottle *F*, and the 12-mesh soda lime in the jar *G*, although the principal function of the liquid in *F* is to serve as an indicator of the rate of flow of the gas. The mercury seal *I*, prevents any possibility of back flow of the gases in the combustion tube. After passing through the mercury seal the oxygen enters the combustion tube *J*, which is provided with tightly-fitting one-hole rubber stoppers and with water jackets, *K* and *L*, at the ends. The clear solution of barium hydroxide (20 g. per liter) in the bottle *S*, is arranged so that it can be conveniently siphoned into the eight-bulb Meyer tube, *O*. The barium carbonate is filtered on the Buchner funnel *X*, shown fitted to the filter flask *P*, and the precipitate is washed with carbon-dioxide-free distilled water (prepared by bubbling through the water, compressed air previously freed from carbon dioxide by passage through the soda-lime bottle *T*, delivered by gravity from the bottle *U*). The standard 0.1 *N* solutions of NaOH and HCl are delivered by gravity to the burettes, *R*, from the bottles *V* and *W*. The small hot plate *Q*, is used for warming the flask containing the barium carbonate and the measured amount of 0.1 *N* HCl, in order to cause rapid and complete solution of the precipitate.

METHOD

The furnace having been previously heated to approximately 1100° C., all air having been displaced from the apparatus by passage of a stream of pure oxygen, and the Meyer tube having been filled with sufficient barium hydroxide solution (20 g. per liter) to fill seven of the eight bulbs when the oxygen is passing at the maximum rate, the boat is quickly inserted, by means of a stout copper rod, into the hottest part of the furnace and the stopper immediately replaced. Allow the boat and its contents to heat for about 1 minute with no oxygen passing, this will result in some oxygen being absorbed by the iron, and the barium hydroxide being drawn back into the large bulb as a consequence of the partial vacuum resulting therefrom. At the expiration of about one minute, admit oxygen to the tube at a rate of approximately 340 cc. per minute (as indicated by the gage, which should read about $1\frac{1}{2}$ in.). Complete combustion of the ingot iron, and the alloy sample, with vivid incandescence, should result in $1\frac{1}{2}$ to 2 minutes. Preliminary heating followed by the rapid admission of oxygen are absolutely essential to securing complete combustion in the short time allowed. Only in case the oxides are so thoroughly fused as to show no trace of the shape of the original drillings when the boat is removed from the furnace, should the combustion be considered to have been successful. Upon the appearance of the faintest cloudiness in the first bulb of the Meyer tube, decrease the rate of flow immediately to 100 cc. per minute (about 1 in. on the gage), and maintain it so to the end of the operation. If the rate of flow after the first noticeable formation of barium carbonate is much less or much greater than 100 cc. per minute, low carbon results will be obtained, due either to some carbon dioxide not having been swept out of the apparatus in the time specified, or to some having escaped absorption in the barium hydroxide. Passage of oxygen for a total of 5 minutes is sufficient to sweep all carbon dioxide from the combustion tube.

At the conclusion of the above described operations (6 minutes after the boat was inserted into the furnace) remove the boat, and filter the contents of the Meyer tube on two super-imposed, open-grain, 11-cm. filter papers supported on a Buchner funnel fitted to a suction flask. Wash the Meyer tube three times with water free from carbon dioxide (prepared by passing compressed air through soda-lime and then bubbling it through the distilled water), taking care to reach all points of the tube; then give the precipitate and paper four additional washings. Delivery of the water from an overhead bottle rather than from a wash flask avoids danger of contamination from the carbon dioxide of the breath, besides being more convenient and sanitary. Transfer the paper and precipitate to a 500-cc. Erlenmeyer flask and add from a burette enough standard 0.1 N HCl solution to dissolve the barium carbonate and add 5 cc. in excess, a portion of the acid being used to rinse the Meyer tube, which is then further rinsed with water. Place the flask containing the precipitate on a hot plate until the carbonate has dissolved; long heating should be avoided as it apparently causes some action on the filter paper involving a slight error in the determination. Introduce 5 or 6 drops of methyl orange into the solution and determine the excess of HCl by titration with a standard 0.1 N solution of NaOH, the end point being marked by the color change from red to yellow. One cubic centimeter of standard 0.1 N HCl equals 0.000600 g. of carbon.

A blank should be run on the ingot iron, boat, filter paper, etc., and any carbon found should be deducted from that obtained in the analysis. A 2-g. sample of ingot iron should be used, and the determination made by the method as just described.

Accuracy.—In the case of a carbon content of 0.05 per cent, duplicate determinations should check within ±0.01 per cent carbon.

DETERMINATION OF INSOLUBLE RESIDUE

METHOD

The sample should weigh at least 5 g. and if the alloy is known to be low in insoluble residue a 10-g. sample should be used. Treat the sample with from 200 to 400 cc. of HCl (sp. gr. 1.19) at a temperature of from 60 to 70° C. until the reaction appears to be complete, then add 1 to 2 cc. of HNO_3 (sp. gr. 1.42). Boil the solution for about 2 minutes, dilute with an equal volume of hot water, filter, and wash the filter thoroughly with hot dilute HCl (5:95).

Ignite the residue at a low heat in a platinum crucible, treat with HF and several drops of dilute H_2SO_4 (1:1), and evaporate the solution just to fumes of sulfur trioxide. If any residue remains, add 10 cc. of water to the crucible, filter on a 9-cm. paper and wash the residue with hot water. Ignite any residue remaining on the paper and weigh. The increase in weight multiplied by 100 and divided by the weight of sample taken gives the percentage of insoluble residue.

Accuracy.—In the case of an insoluble residue of 0.05 per cent, duplicate determinations should check within ±0.02 per cent insoluble residue.

DETERMINATION OF SILICON

METHOD

Treat a 2-g. factor-weight sample (0.9344 g.) to a 5-g. factor-weight sample (2.3360 g.) in a 300-cc. porcelain casserole with 30 to 50 cc. of HCl (sp. gr. 1.19), the casserole being covered with a watch glass, and warm until the reaction is complete. Add 30 to 50 cc. of dilute H_2SO_4 (1:1), and evaporate just to fumes of sulfur trioxide. Allow the casserole to partly cool, add 200 cc. of warm water and boil briskly for several minutes to dissolve all salts. Filter the silica on an 11-cm. paper containing some ashless paper pulp, wash five or six times with dilute HCl (1:100), and finally with hot water until free from acid.

Ignite the paper and the precipitate in a small platinum crucible, first at a dull-red heat until the carbon of the filter paper has been oxidized, and finally at 1050 to 1100° C. Allow the crucible to cool in a desiccator and weigh. Add 1 or 2 drops of H_2SO_4 (sp. gr. 1.84), several cubic centimeters of HF, and evaporate the solution until all the H_2SO_4 has been expelled. Ignite the crucible again, cool, and weigh. The difference between the first and the second weights, multiplied by 100 and divided by the weight of sample taken, gives the percentage of silicon in the sample. In case the silica precipitate contains any undissolved material, ignite the paper and the precipitate at a dull-red heat until the carbon of the filter paper has been oxidized, transfer to a 30-cc. pure-iron crucible, and fuse with approximately 5 g. of sodium peroxide. When cool, transfer the melt to a 300-cc. porcelain casserole and dissolve in 50 cc. of water. Add 50 cc. of dilute H_2SO_4 (1:1), and evaporate the solution just to fumes of sulfur trioxide. From this point proceed as described above.

Accuracy.—In the case of a silicon content of 0.2 per cent, duplicate determinations should check within ±0.03 per cent silicon.

DETERMINATION OF SULFUR
BY THE
EVOLUTION-TITRATION METHOD

This method is based on (1) the evolution of practically all the sulfur in the alloy as hydrogen sulfide when the alloy is dissolved in HCl (sp. gr. 1.19) (see Note); (2) absorption of the evolved gas by means of an ammoniacal solution of cadmium chloride; and (3) determination of the sulfur by titration with a standard solution of potassium iodate (0.0312 *N*).

SOLUTIONS REQUIRED

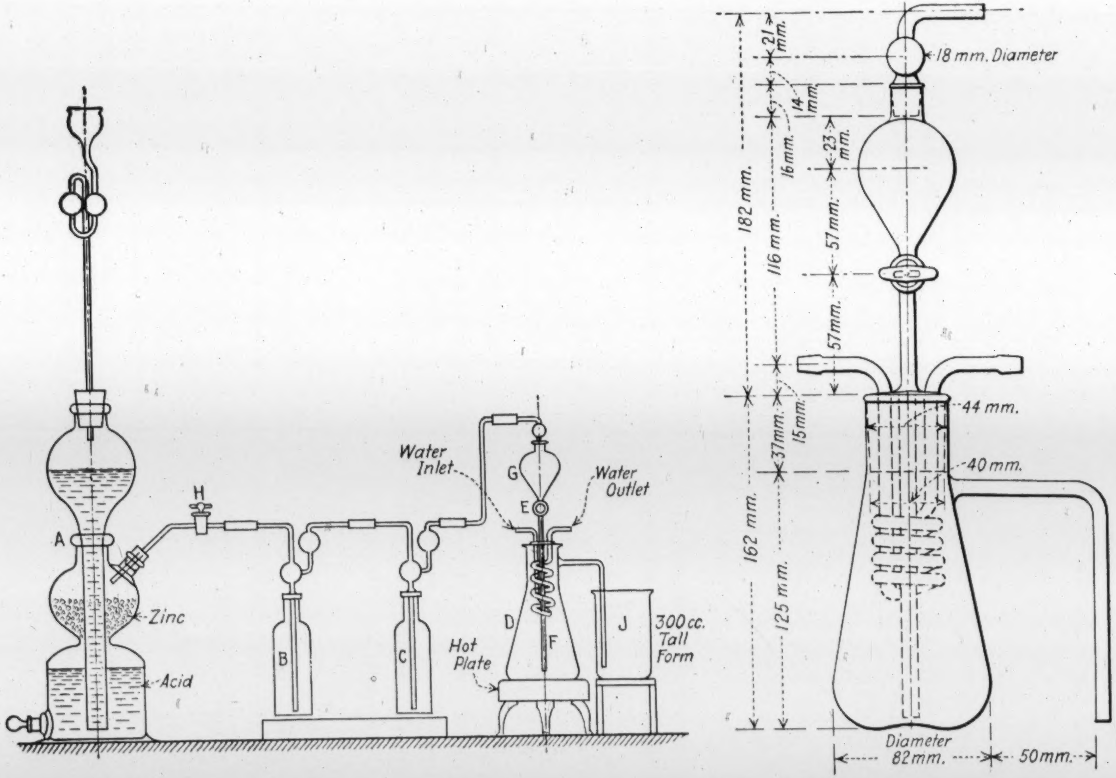
Potassium Permanganate Solution (2.5-per-cent).—Dissolve 2.5 g. of $KMnO_4$ in 100 cc. of water.

Sodium Hydroxide (30-per-cent).—Dissolve 30 g. of NaOH in 100 cc. of water.

Cadmium Chloride Solution.—Dissolve 10 g. of $CdCl_2 \cdot 2H_2O$ in 400 cc. of water and 600 cc. of NH_4OH (sp. gr. 0.90).

Starch Solution.—Dissolve 1.2 g. of soluble starch in 100 cc. of boiling water, cool to room temperature and add a solution of 0.5 g. of KI dissolved in 10 cc. of cold, freshly distilled water. The starch solution shall not be used if it is over one day old.

Standard Potassium Permanganate (0.03 N).—Dissolve 0.99 g. of pure $KMnO_4$ in 1000 cc. of hot distilled water, boil for 10 minutes, cool to room temperature and filter through asbestos. Standardize against the U. S. Bureau of Standards standard sodium oxalate as follows: In a 200-cc. beaker, dissolve 0.1 g. of sodium oxalate in 75 to 100 cc. of hot water (80 to 90° C.) and add 4 cc. of H_2SO_4 (1:1). Titrate at once with the permanganate solution, stirring the liquid vigorously and continuously. The permanganate must not be added more rapidly than 10 to 15 cc. per minute, and the last 0.5 to 1 cc.


A
Zinc
Acid
H
B
C
Water Inlet
G
E
Water Outlet
D
F
Hot Plate
J
300 cc. Tall Form
182 mm.
162 mm.
21 mm.
14 mm.
16 mm.
116 mm.
23 mm.
57 mm.
57 mm.
37 mm.
15 mm.
125 mm.
18 mm. Diameter
44 mm.
40 mm.
Diameter 82 mm.
50 mm.

Decomposition Flask, Pulsifer Design.,

FIG. 2.—Apparatus for Determination of Sulfur by the Evolution-Titration Method.

must be added dropwise, with particular care to allow each drop to be fully decolorized before the next is introduced. The excess of permanganate used to cause an end-point color must be estimated by matching the color in another beaker containing the same bulk of acid and hot water. The temperature of the solution should not be below 60° C. by the time the end point is reached. Calculate the exact normality of potassium permanganate from the sodium oxalate.

Standard Sodium Thiosulfate (0.03 N).—Dissolve 7.5 g. of $Na_2S_2O_3 \cdot 5H_2O$ in 1000 cc. of freshly boiled, distilled water at room temperature. To 250 cc. of distilled water in a 500-cc. flask add 1 g. of KI and 10 cc. of HCl (1:1). Cool and add 35 cc. of the standard potassium permanganate solution (0.03 *N*) from a burette. Swirl gently and titrate the liberated iodine with the thiosulfate solution to a light straw color. Add several cubic centimeters of the freshly prepared starch solution and continue the titration to the disappearance of the blue color. Calculate the normality of the thiosulfate solution from the standard permanganate solution.

Standard Potassium Iodate (0.0312 N).—Dissolve 1.12 g. of pure KIO_3, and 12 g. of KI in 1000 cc. of distilled water. To 250 cc. of cold distilled water in a 500-cc. flask, add 10 cc. of HCl (1:1) and then as the flask is gently swirled, add 35 cc. of the iodate solution from a burette. Titrate the liberated iodine with the standard sodium thiosulfate solution (0.03 *N*) to a light straw color, add several cubic centimeters of the freshly prepared starch solution and continue titration to the disappearance of the blue color. Calculate the normality of the iodate solution and adjust the solution so that 1 cc. is equivalent to 0.0005 g. of sulfur.

APPARATUS

Figure 2 illustrates the details of the apparatus employed. Hydrogen supplied from the Kipp generator, *A*, is freed from any sulfur by passage through a solution of potassium permanganate (2.5-per-cent) contained in a Drechsel bottle, *B*, and sodium hydroxide (30-per-cent) held in the Drechsel bottle, *C*. Hydrogen is admitted through a glass stopcock, *E*, to the decomposition flask, *D*. The decomposition flask (Pulsifer's design) is provided with a ground-glass stopper, *E*, a funnel, *G*, and a cooling coil, *F*, with inlet and outlet tubes. An ammoniacal solution of cadmium chloride or some other suitable absorbent is held in a 300-cc. beaker, *J*. The absorption should not be carried on in direct sunlight.

NOTE.—It is advisable to use an all-glass apparatus because the length of time (30 minutes) required for the solution of the alloy gives opportunity for fumes of hydrochloric acid to attack rubber stoppers and rubber hose connections, which always contain sulfur, and thus cause erroneous results.

METHOD

Transfer to the decomposition flask 5.00 g. of the alloy ribbon which has been cut into very small pieces or of the wire sample which has been flattened by means of a hammer and cut into small pieces. Pass a stream of hydrogen from the Kipp generator through the apparatus to displace the air. Pour 25 cc. of cadmium chloride solution into the beaker, *J*, and add sufficient water to give a depth of 3 in. of the solution. Stop the hydrogen by closing the control stopcock, *H*, on the Kipp generator. Close the stopcock *E*. Remove the ground-glass tube leading into the funnel, *G*, and introduce 100 cc. of HCl (sp. gr. 1.19) (see Note) into the decomposition flask through the funnel. As soon as the acid has been added, replace the ground-glass inlet tube, open the stopcock, *E*, and pass a steady stream of hydrogen through the apparatus during the remainder of the determination. Apply sufficient heat to the decomposition flask to maintain a steady decomposition of the sample. Passage of a stream of cold water through the cooling coil, *F*, of the decomposition flask serves to cool the stopper and to aid in maintaining the strength of the acid in the flask. Thirty minutes of this treatment is ordinarily sufficient to cause complete decomposition. When there is no further action, boil the solution in the decomposition flask for several minutes and continue the stream of hydrogen for 5 minutes longer.

At the end of this time remove the absorption beaker, *J*, close stopcock, *E*, and the control stopcock, *H*, and discontinue heating the decomposition flask. Filter the cadmium chloride solution through an 11-cm. filter paper and wash the precipitate several times with water. Return the paper and precipitate to a 600-cc. beaker, add 300 cc. of cold water and 40 cc. of dilute HCl (1:1) and titrate the liberated hydrogen sulfide with the standard solution of potassium iodate, starch solution being used as an indicator.

Carry a blank through all steps of the process and deduct any sulfur that is found.

If the potassium iodate solution has been adjusted to 0.0312 *N* and 5 g. of the alloy has been dissolved, then the percentage of sulfur is 0.01 times the number of cubic centimeters of the iodate solution used.

NOTE.—There is a question whether concentrated HCl or dilute HCl should be used. This method calls for concentrated HCl. See article by Pulsifer, "A Standard Apparatus for the Determination of Sulfur in Iron and Steel by the Evolution Method" in *Industrial and Engineering Chemistry*, p. 545, 1918.

OPTIONAL METHOD

For an optional method see the Determination of Sulfur by the Evolution-Titration Method (Routine) in the Standard Methods of Chemical Analysis of Plain Carbon Steel (A.S.T.M. Designation: A 33) of the American Society for Testing Materials.[1] This optional method may be used for Nickel-Chromium and for Nickel-Iron-Chromium Alloys with the following precautions:

1. Due to the length of time (30 minutes) required for solution of the alloy, closer observation is necessary than in the analysis of steel.
2. During the solution of the sample, care must be exercised in order that the absorbing solution is not drawn back into the flask.
3. There is danger of contamination from rubber hose connections and rubber stoppers.
4. The use of a gas flame is a possible source of sulfur contamination and an electric heater is recommended.

Accuracy.—In the case of a sulfur content of 0.05 per cent, duplicate determinations should check within ±0.003 per cent sulfur.

DETERMINATION OF COPPER

A. NICKEL-COPPER ALLOYS CONTAINING 10 TO 90 PER CENT COPPER

SOLUTIONS REQUIRED

Dilute Nitric Acid (1:3).—Slowly stir 50 cc. of HNO_3 (sp. gr. 1.42) into 150 cc. of distilled water.

Dilute Sulfuric Acid (1:1).—Slowly stir 10 cc. of concentrated H_2SO_4 (sp. gr. 1.84) into 10 cc. of water.

METHOD

Dissolve exactly 2.000 g. of the alloy in 25 cc. of the dilute HNO_3 (sp. gr. 1.135) and when solution is complete, boil to expel nitrous fumes and dilute with about 175 cc. of cold water. Add 5 cc. of the dilute sulfuric acid (1:1).

Determine the copper by electrolysis. Use a current of 0.5 ampere unless the solution is agitated, in which case a larger current up to 4 amperes may be used.

Accuracy.—Duplicate determinations should check within ±0.10 per cent of copper.

NOTE.—A little copper may be retained by the iron precipitate. The presence of molybdenum or silver will cause high results for copper.

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[1] **1927 Book of A.S.T.M. Standards, Part I, p. 293.**

B. COPPER UP TO 5 PER CENT IN ALLOYS OF CHROMIUM WITH IRON OR NICKEL OR BOTH

SOLUTIONS REQUIRED

Ferric Sulfate.—Dissolve 0.8 g. of ferric sulfate ($Fe_2(SO_4)_3 \cdot 9\,H_2O$) in 100 cc. of distilled water.

Dilute Sulfuric Acid (1:4).—Slowly stir 50 cc. of H_2SO_4 (sp. gr. 1.84) into 200 cc. of distilled water.

Dilute Sulfuric Acid (1:1).—Slowly stir 100 cc. of H_2SO_4 (sp. gr. 1.84) into 100 cc. of distilled water.

Acidified Hydrogen Sulfide Water.—Mix 10 cc. of HCl (sp. gr. 1.19) and 1000 cc. of distilled water and saturate with H_2S.

Ammonium Hydroxide (sp. gr. 0.90).

METHOD

Dissolve exactly 5.000 g. of the alloy in a 400-cc. covered beaker in 100 cc. of HCl (sp. gr. 1.19) at about 65° C. When the reaction is complete, dilute to approximately 300 cc. with warm water. Introduce ammonium hydroxide (sp. gr. 0.90) until the solution is practically neutral and then add sufficient HCl (sp. gr. 1.19) to give an acidity of 3 cc. of HCl (sp. gr. 1.19) per 100 cc. of solution. Treat the solution with a brisk stream of hydrogen sulfide for at least 30 minutes.

Filter the precipitate of sulfide on a 9-cm. paper containing a small amount of paper pulp and wash thoroughly with the acidified hydrogen sulfide water. Discard the filtrate.

Return the paper and the precipitate to a 250-cc. covered beaker and treat with 3 cc. of H_2SO_4 (sp. gr. 1.84) and 25 cc. of HNO_3 (sp. gr. 1.42) and evaporate slowly to fumes of sulfur trioxide. Add sufficient HNO_3 (sp. gr. 1.42) in small quantities to completely oxidize the filter paper and subsequently heat the solution until strong fumes of sulfur trioxide are evolved and all HNO_3 has been expelled.

Add 25 cc. of the ferric sulfate solution to the cooled sulfuric acid solution and add ammonium hydroxide (sp. gr. 0.90) in small excess. Heat the solution to boiling and after the precipitated ferric hydroxide has settled, filter on a 9 cm. paper and wash with hot water.

Dissolve the precipitate in a small amount of hot dilute H_2SO_4 (1:4) and wash the filter with water. Repeat the ammonia precipitation and the filtration and combine the filtrates. Acidify with an excess of 5 cc. of H_2SO_4 (1:1), add 1 cc. of HNO_3 (sp. gr. 1.42) and evaporate to approximately 100 cc.

Determine the percentage of copper by electrolysis, using a perforated platinum cathode and a spiral anode.

In case a trace of copper is to be determined, start with four 5-g. portions of sample and combine them after the hydrogen sulfide precipitates have been filtered.

Accuracy.—Duplicate determinations should check within ±0.02 per cent copper.

NOTE—A little copper may be retained by the iron precipitate. The presence of molybdenum or silver will cause high results for copper

TENTATIVE ACCELERATED LIFE TEST
FOR
METALLIC MATERIALS FOR ELECTRICAL HEATING[1]

A.S.T.M. Designation: B 76 - 29 T

This is a **Tentative Standard**, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope.

1. This method[2] covers the determination of the resistance to oxidation at high temperatures under intermittent heating of metallic materials for electrical heating. The method is applicable to two general classes of metallic materials for electrical heating, as follows:

Class A.—Alloys suitable for commercial service up to 1100° C. (2012° F.).

Class B.—Alloys suitable for commercial service up to 900° C. (1652° F.).

NOTE.—A typical Class *A* alloy is one of 80 per cent nickel and 20 per cent chromium; a typical Class *B* alloy is one of 60 per cent nickel, 15 per cent chromium and 25 per cent iron.

APPARATUS

Test Board.

2. (*a*) *Size and Location.*—The dimensions of the test board shall conform to those shown in Fig. 1. The test board shall be located in a position free from draughts of air.

NOTE.—Even a slight draught of air in contact with the specimen will cause excessive variation in the length of life.

(*b*) *Upper Terminal.*—The upper terminal shall consist of a binding post attached to a rod passing through another binding post or through the upper bus bar. This provides for adjustment laterally and vertically, as shown in Fig. 1.

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. F. E. Bash, Secretary of Committee B-4 on High-Temperature and Electrical-Resistance Alloys, Technical Department, Driver-Harris Co., Harrison, N. J.

[2] Further information on this method of test is given in a paper by F. E. Bash and J. W. Harsch, "Life Tests on Metallic Resistor Materials for Electrical Heating," *Proceedings*, Am. Soc. Testing Mats., Vol. 29, Part II, p. 506 (1929).

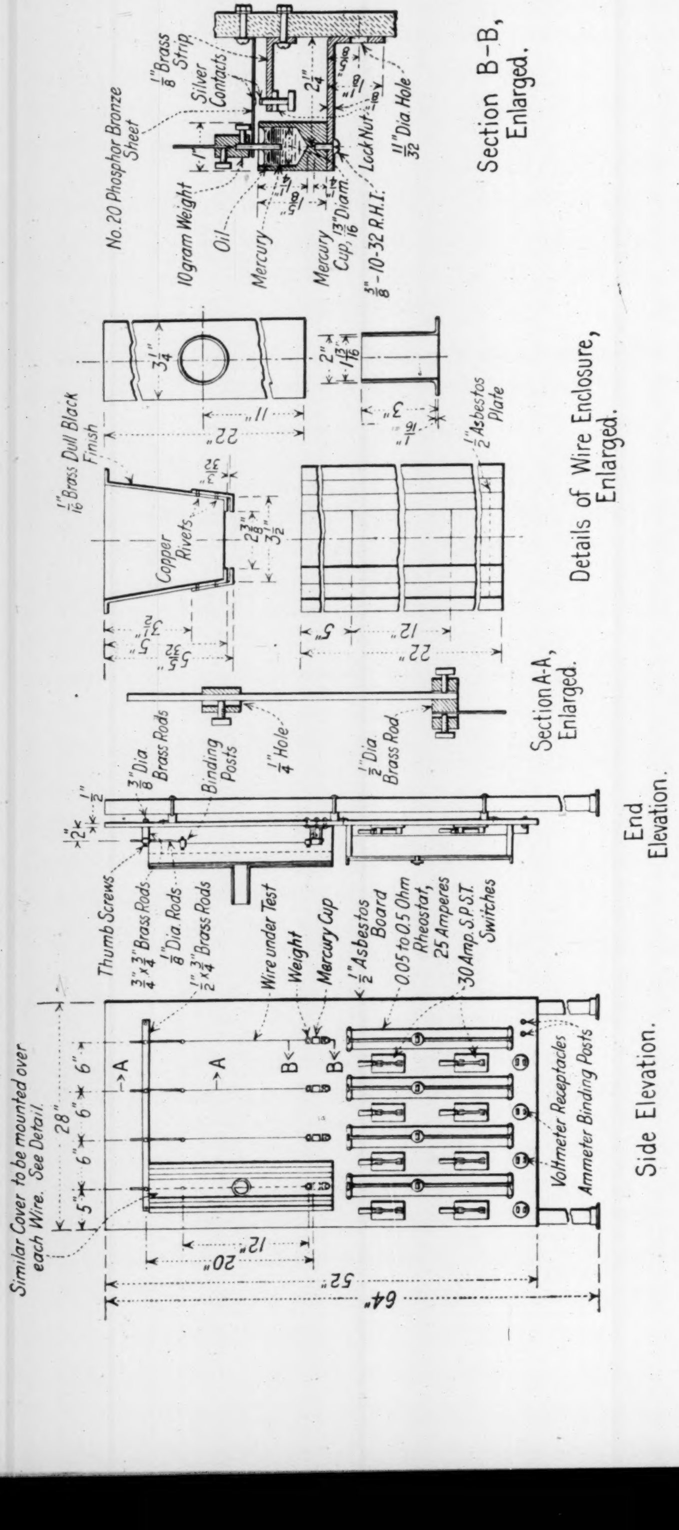

Similar Cover to be mounted over each Wire. See Detail.
28"
5"
6"
6"
6"
A
A
B
B
12"
20"
52"
64"
Thumb Screws
3/4" x 3/4" Brass Rods
1/8" Dia. Rods
1/2" x 3/4" Brass Rods
Wire under Test
Weight
Mercury Cup
1/2" Asbestos Board
0.05 to 0.5 Ohm Rheostat, 25 Amperes
30 Amp. S.P.S.T. Switches
Voltmeter Receptacles
Ammeter Binding Posts
Side Elevation.
1/2"
1/2"
3/8" Dia Brass Rods
Binding Posts
End Elevation.
1/4" Hole
1/2" Dia Brass Rod
Section A-A, Enlarged.
1/16" Brass Dull Black Finish
3/32"
Copper Rivets
2 3/8"
3 1/2"
3 1/2"
5"
5 5/32"
5"
12"
22"
1/2" Asbestos Plate
22"
11"
3 1/4"
2"
1 13/16"
3"
1/16"
Details of Wire Enclosure, Enlarged.
No. 20 Phosphor Bronze Sheet
1/8" Brass Strip
Silver Contacts
10 gram Weight
1"
2 1/4"
Oil
Mercury
Mercury Cup, 13/16" Diam.
3/8" - 10-32 R.H.T.
Lock Nut
11/32" Dia. Hole
Section B-B, Enlarged.

FIG. 1.—Test Board for Accelerated Life Test.

(*c*) *Lower Terminal.*—The mercury cup constitutes the lower terminal. A weight which will develop a stress of 35 lb. per sq. in. in the wire shall be attached to the lower end of the specimen, as shown in Fig. 1. This is equivalent to a weight of 10 g. for wire 0.0285 in. in diameter.

NOTE.—Experiments have shown that at high temperatures alloys of Classes *A* and *B* are subject to plastic flow when under relatively light load. The weight specified above does not cause appreciable increase in length during the test.

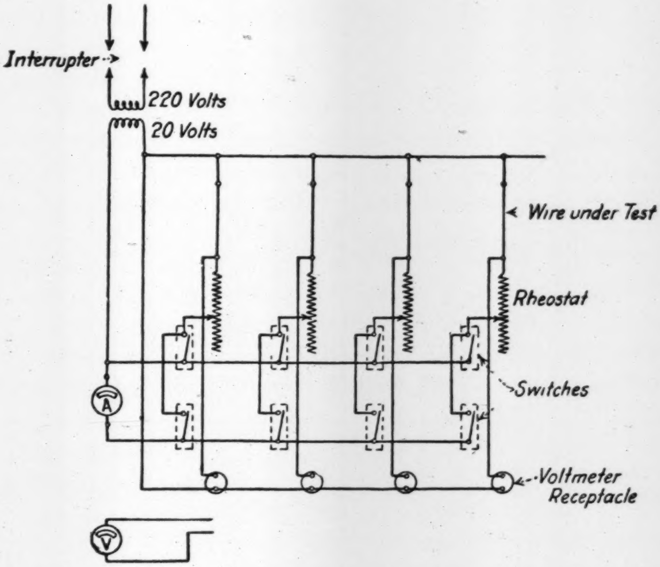


FIG. 2.—Electrical Circuit Diagram for Accelerated Life Test.

3. (*a*) The test apparatus shall conform to the requirements specified in Paragraphs (*b*) to (*h*), inclusive, and shall be connected as shown in Fig. 2. **Test Apparatus.**

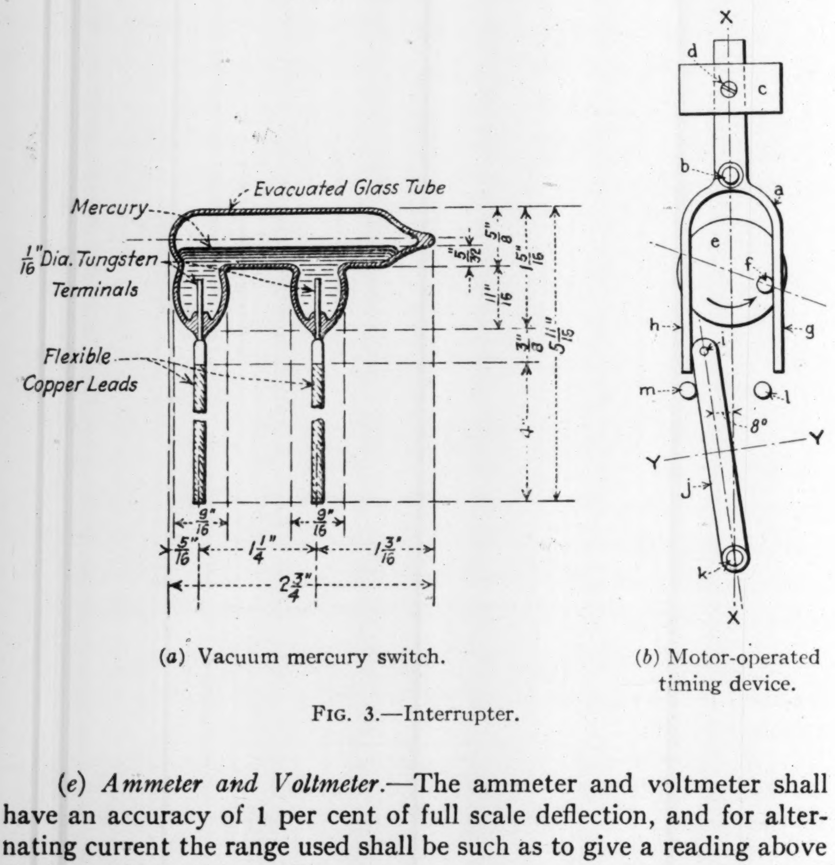
(*b*) *Power Supply.*—The transformer or motor generator set shall be capable of delivering a controlled voltage of from 10 to 20 volts to the circuit. It shall have a continuous current capacity of 20 amperes per specimen.

(*c*) *Voltage Control.*—The automatic voltage control shall be capable of maintaining across the bus bars a constant voltage within plus or minus 0.5 per cent.

NOTE.—It has been found impossible to make accurate tests without voltage control, as changes in line voltage were sufficient to cause considerable variation in the results obtained.

(*d*) *Rheostat.*—The rheostat shall be capable of adjusting the current through the specimen to within approximately 0.25 per cent of any desired value within the working range and shall have a continuous current rating of approximately 25 amperes.

NOTE.—A tubular, wire-wound or ribbon-wound sliding contact rheostat, having a working range of adjustability from approximately 0.05 to 0.5 ohms, provides for testing wires within a considerable range of size and resistivity.


Evacuated Glass Tube
Mercury
1/16" Dia. Tungsten Terminals
Flexible Copper Leads
5/8"
5/32"
15/16"
11/16"
3/8"
5 11/16"
4"
9/16"
9/16"
5/16"
1 1/4"
1 3/16"
2 3/4"
X
d
c
b
a
e
f
h
g
i
m
l
8°
Y
Y
j
k
X

(*a*) Vacuum mercury switch.

(*b*) Motor-operated timing device.

FIG. 3.—Interrupter.

(*e*) *Ammeter and Voltmeter.*—The ammeter and voltmeter shall have an accuracy of 1 per cent of full scale deflection, and for alternating current the range used shall be such as to give a reading above the lower fifth of the scale range.

(*f*) *Optical Pyrometer.*—The optical pyrometer shall be of the disappearing filament type. The optical system shall be such as to provide a magnification of at least four diameters. This may be accomplished by the use of a lens or combination of two lenses in the objective to provide a short focal length and the desired magnification.

NOTE.—It is highly important that the temperature of the test specimen be adjusted as accurately as possible, as small variations in temperature result in considerable variation in length of life. A disappearing filament type of optical pyrometer makes it possible to determine the temperature at any particular point on the wire and with the arrangement described the temperature of a comparatively small wire may be taken quite readily after it is magnified.

(*g*) *Interrupter.*—Some form of apparatus shall be used as an interrupter to open and close the circuit. A motor-operated vacuum mercury switch is recommended. An arrangement which has given satisfactory results is illustrated in Fig. 3. The mercury switch is operated by the device shown in Fig. 3 (*b*) by tilting it about an axis perpendicular to the plane of the drawing. The operating device consists of a forked lever, *a*, pivoted about a horizontal axis through *b*, and carrying a weight, *c*, whose vertical position is adjustable by the set-screw, *d*. A motor-operated timing wheel, *e*, carries a pin, *f*, which engages the prong, *g*, and tilts the forked lever, *a*, about the axis, *b*. Actuated by gravity, the forked lever continues to rotate and the prong, *h*, engages a pin, *i*, attached to a movable arm, *j*. The movable arm rotates about a horizontal axis, *k*, until halted by a stop, *l*. The mercury switch attached to the arm, *j*, with its longitudinal axis along the axis *Y-Y* is thus quickly tilted from the extreme right position to the extreme left position and *vice versa* as the rotation of the timing wheel continues. The apparatus shall provide a total angular movement of 15 deg. and the operating device actuated by the timing clock or motor shall be such that the mercury switch will tilt from the extreme "on" position to the extreme "off" position in one quick movement. This is necessary since the surface tension causes the angular position at which the circuit is made to be slightly different from that at which it is broken.

(*h*) *Apparatus for Recording Time of Burnout.*—If no apparatus is available for recording the time of burnout, arrangements shall be made for hourly observations for burnouts. Small thermocouples made from fine wire may be attached to the test board and the hot junction placed near the specimen under test. A multiple-point recording pyrometer may be attached to the thermocouples, which will give a complete record of the number of cycles. If no recording pyrometer is available some form of bell ringing device may be used as shown in Fig. 1.

TEST SPECIMEN

Test Specimen.

4. (*a*) The test specimen shall not be larger than No. 20 A.w.g. nor smaller than No. 22 A.w.g. The length of wire selected for test

shall be such as to permit the use of a 12-in. test length between the two terminals.

(*b*) The test specimen shall be representative, as regards surface, of the average of the coil or spool of wire which has been selected for test. Particular care shall be taken to see that the specimen selected is free from kinks. This is necessary, as a kink, even though later removed, may cause burnout at that point.

NOTE.—It is also very desirable to select and keep as a standard of comparison a spool or coil of wire which is uniform in cross-section from one end to the other. Tests may then be made at any time on the standard, and if conditions have changed they will be noted by the length of life on the standard. Comparisons between tests made at different times between the standards and other wires may be correlated in this manner.

PROCEDURE

Mounting of Specimens.

5. (*a*) The test specimens shall be mounted on the test board in a vertical position, as shown in Fig. 1, and shall be spaced as follows:

Distance between test board and specimens	2 in.
Distance between specimens	6 in.
Distance between specimen and shield	2 in.
Distance between upper bus bar and mercury cup	20 in.

NOTE.—This recommendation is based on a series of tests run in four laboratories to determine the best position for the specimen in which horizontal mounting, catenary mounting and vertical mounting were compared. The results of the tests indicated that the vertical mounting gave the best results and was most convenient. It might be expected that the vertical wire would be a great deal hotter near the top than near the bottom. This does not appear to be the case due to the fact that convection currents are greater near the top, and therefore largely compensate for variations that otherwise would occur.

(*b*) In mounting a test specimen, one end of the specimen shall be inserted in the upper terminal and the 10-g. weight attached to the other end. The upper terminal shall then be so adjusted as to give a test length of the wire of approximately 12 in. between the two terminals. Care shall be taken to see that the wire projecting into the mercury cup will be able to move freely and will not touch the bottom after the sample has expanded upon heating. A clearance of ½ in. between the bottom of the cup and the end of the wire will be sufficient.

Ballast Resistance.

6. The voltage between the bus bars shall be adjusted so that it will not be necessary to make the ballast resistance in series with the specimen greater than 20 per cent of the resistance of the specimen.

Temperature of Test.

7. Alloys of Class *A* shall be tested at a temperature of 1066° C. (1950° F.) and alloys of Class *B* at a temperature of 1010° C. (1850° F.).

Procedure.

8. The procedure shall be carried out as described in Paragraphs (*a*) to (*m*), inclusive.

(*a*) Adjust the filament current of the optical pyrometer to the value corresponding to the test temperature specified in Section 7. Support the pyrometer telescope so that it can be quickly adjusted and read.

NOTE.—The interrupter shall not be in operation while the temperature is being adjusted.

(*b*) Set the series rheostat at maximum resistance.

(*c*) Close the switch in series with the specimen, recording the time of starting the test.

(*d*) Cut out the resistance in the rheostat rapidly until the specimen is at a low red heat.

(*e*) Grasp the 10-g. weight in a pair of pliers and apply a slight tension, sufficient to straighten the wire.

(*f*) Readjust the filament current of the pyrometer to the value corresponding to the test temperature.

(*g*) Adjust the rheostat slider until the specimen exactly matches the lamp filament in brightness. Maintain this balance until one and one-half minutes have elapsed from the starting of the test.

(*h*) Allow the test to continue until nine minutes have elapsed from the time of starting the test. Then, after carefully resetting the current in the optical pyrometer readjust the temperature of the specimen to the test temperature. Final adjustment shall be completed within ten minutes from the time of starting the test. It is extremely important that the time schedule specified shall be rigidly adhered to. If a greater amount of time than that specified is taken to make the adjustments, the specimen shall be discarded, another one put in its place and the test again started.

(*i*) Record the voltage and the current, together with the starting temperature and the starting time at the end of the ten-minute period.

(*j*) Start the interrupter, the timing device of which shall have been previously regulated so that the "on" period and the "off" period shall be equal and shall each have a duration of two minutes.

NOTE.—Various cycles have been tried varying from 10 minutes on and 5 minutes off to 30 seconds on and 30 seconds off, when it was found that the 2 minutes on and 2 minutes off cycle gave the shortest life for a given temperature. It appears that sufficient cooling time has to be allowed to permit the specimen to reach a low enough temperature to cause any loosening or cracking of scale which will occur due to variations in coefficient of expansion of the scale and the metal. The heating and cooling operation is more injurious to wire than maintaining it at a definite temperature.

(*k*) Adjust the temperature to the standard test temperature after 3 hours, 7 hours, and 24 hours total elapsed time. Record the voltage and current after each resetting. Stop the interrupter before each resetting and start it again after making the observation.

(*l*) After the first 24-hour period the test shall be allowed to run without readjustment for the next 24 hours. At the end of this period and every 24 hours thereafter until burnout, the rheostat shall be readjusted, so that the voltage drop across the specimen will be the same as that noted at the end of the first 24 hours.

(*m*) After each adjustment of the voltage, the current and temperature measurements shall be observed and recorded. In determining the temperature, if the wire has developed hot spots, a number of readings at various points shall be obtained and the average taken, disregarding any noticeable hot spots.

Record. 9. Measurements and observations shall be recorded on a data sheet similar to that shown in Table I.

Report. 10. The report shall include the following:

(*a*) Class of alloy;

(*b*) Identification of specimen;

(*c*) Cross-sectional dimensions of the specimen;

(*d*) Life of the specimen in hours (total elapsed time from the end of the first ten minute aging period to burnout);

(*e*) The elapsed time in hours to 10 per cent increase in resistance, starting after the end of the first ten-minute aging period;

(*f*) A curve showing the relation between resistance and time.

REPRODUCIBILITY

Reproducibility. 11. In the course of the development of this test method, it has been found that the major source of irregularity is in respect to temperature measurement. Therefore, no attempt shall be made to run standard accelerated life tests until it has been definitely proved that the operator can obtain consistent results with specimens taken from the same sample coil or spool. Four or five specimens shall be tested at the same time to make sure that no variables, such as errors in temperature measurement, would affect one test and not another. Consecutive tests also shall be run. If the tests are properly made and controlled, the life of a number of specimens cut from the same spool should not vary more than ± 7.5 per cent from the average.

TABLE I.—DATA SHEET FOR ACCELERATED LIFE TEST RECORD.

ACCELERATED LIFE TEST RECORD

Class of Alloy..

Laboratory Name.. Sample No..

Dimensions of Specimen	Test Temperature, deg. Cent.	Bus Voltage	

Date	Time	Elapsed Time, hours	Voltage across Specimen after Adjustment, volts	Current through Specimen after Adjustment, amperes	Resistance of Specimen after Adjustment, ohms	Temperature after Adjustment, deg. Cent.

Life of Specimen, hours	Final Resistance, Percentage of Resistance at End of 10 Minutes	Elapsed Time to 10 Per Cent Increase in Resistance Starting from End of First 10 Minutes, hours

REMARKS

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TENTATIVE SPECIFICATIONS
FOR
KEENE'S CEMENT[1]

A.S.T.M. Designation: C 61 – 29 T

This is a Tentative Standard, published for the purpose of eliciting criticism **and suggestions, and as such is subject to annual revision.**

ISSUED, 1926; REVISED, 1928, 1929.

Various manufacturers offer to the trade several grades of Keene's cement of different fineness and setting times. These specifications are applicable to the grades manufactured for use in the base and finish coats of plastering. Grades intended for use in Scagliola, castings and other special purposes, should conform to the requirements of these specifications in all respects except those for fineness and time of set, which will vary according to the particular use for which the grade is designed.

Definition. 1. Keene's cement is anhydrous calcined gypsum, the set of which is accelerated by the addition of other materials.

PROPERTIES

Time of Setting. 2. Keene's cement shall not set in less than 1 hour nor more than 4 hours.

Tensile Strength. 3. The cement shall have a tensile strength of not less than 450 lb. per sq. in. (31.5 kg. per sq. cm.).

Fineness. 4. The cement shall all pass a No. 14 sieve,[2] not less than 98 per cent shall pass a No. 40 sieve and not less than 80 per cent shall pass a No. 100 sieve.

Combined Water. 5. The cement shall not show a combined water content of more than 2 per cent.

SAMPLING

Sampling 6. At least 3 per cent of the packages shall be sampled and shall be so selected as to be representative of the contents of the shipment. Samples shall be taken from both the surface and the center of each package so selected. The material so obtained shall be thoroughly mixed and reduced by quartering to provide not less than a 15-lb. (6.75 kg.) sample for the laboratory.

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[1] **Criticisms of these Tentative Specifications are solicited and should be directed to Mr. H. J. Schweim, Secretary of Committee C-11 on Gypsum, United States Gypsum Co., 300 W. Adams St., Chicago, Ill.**

[2] **For detailed specifications for these sieves, see the Standard Specifications for Sieves for Testing** Purposes (A.S.T.M. Designation: E 11) of the American Society for Testing Materials, 1927 Book of A.S.T.M. Standards, Part II, p. 917.

Laboratory Samples.

7. Each laboratory sample shall immediately be placed in an air-tight container and shipped to the laboratory for test.

METHODS OF TESTING

Methods of Testing.

8. The chemical and physical properties of Keene's cement shall be determined in accordance with the Standard Methods of Testing Gypsum and Gypsum Products (A.S.T.M. Designation: C 26) of the American Society for Testing Materials,[1] except that in the determinations of the time of setting and tensile strength, the consistency used shall be such that a 350-g. modified Vicat needle (Note) shall give a penetration of 15 mm. ± 2 mm., 20 seconds after dropping and the measurement being made 20 minutes after the addition of the Keene's cement to the gaging water. Furthermore, in the determination of testing consistency, 0.1 per cent of commercial retarder may be used.

NOTE.—In all essentials except the plunger, the modified Vicat apparatus is the same as the Vicat apparatus described in the Standard Methods of Testing Gypsum and Gypsum Products (A.S.T.M. Designation: C 26).[1] In the modified apparatus the plunger is made of aluminum tubing. The end that penetrates the mix is ¾ in. in diameter and 1¾ in. in length, the stem is ½ in. in diameter and 6½ in. in length. The amount of penetration is determined by the drop of the plunger as read on the millimeter scale. The weight of the plunger may be varied by loading with shot.

PACKING AND MARKING

Packing and Marking.

9. The cement may be shipped in either packages or in bulk.

(*a*) When shipped for resale, the following information shall be legibly marked on each package or on a tag of suitable size attached thereto:

Name of manufacturer;
Brand;
Description;
Net weight of package.

(*b*) When shipped in bulk, a card containing the required information shall be conspicuously placed in the carrier.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 94.

INSPECTION AND REJECTION

Inspection. 10. Inspection may be made either at the point of shipment or at the point of delivery. The inspector representing the purchaser shall have free access to the carriers being loaded for shipment to the purchaser. He shall be afforded all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere unnecessarily with the loading of the carriers.

Rejection. 11. Any rejection shall be based upon the specific cause of failure to conform to the requirements of these specifications and shall be reported within ten working days from the receipt of the shipment by the consignee.

Rehearing. 12. Claims for rehearing shall be valid only if made within twenty working days from receipt of notice of specific cause for rejection.

APPENDIX

FIELD TEST FOR KEENE'S CEMENT

In many instances it is desirable to have a simple test whereby Keene's cement may be identified. Such a test will not indicate the quality of the cement, which should be determined by the laboratory tests enumerated in the body of these specifications but is of especial value to plasterers, material dealers and superintendents.

The following procedure is satisfactory for this purpose:

Take a cupful of the material; mix with water to the consistency of a thick paste and pour upon a plate or piece of glass. Let stand until fairly firm and definite signs of set having begun are manifest. This will be some time less than two hours, depending on climatic conditions.

Divide the sample, allowing one-half to remain undisturbed. Take the other half and break it down, adding a little water; remix, and then allow it to "set up" again on the plate or glass.

If the material is Keene's cement, the remixed portion will, within a few hours, become quite as hard and strong as the portion that was not remixed.

TENTATIVE SPECIFICATIONS

FOR

CALCINED GYPSUM FOR USE IN THE PREPARATION OF DENTAL PLASTERS[1]

A.S.T.M. Designation: C 72 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1928; REVISED, 1929.

Scope. 1. Calcined gypsums for use in the preparation of dental plasters are products of specific properties with reference to time of setting, fineness and water-carrying capacity. These specifications cover three grades, as follows:

Grade Q (Quick setting);
Grade M (Medium setting);
Grade S (Slow setting).

REQUIREMENTS

Composition. 2. Calcined gypsum for use in the preparation of dental plasters shall contain not less than 93 per cent of calcined gypsum ($CaSO_4 \cdot \frac{1}{2} H_2O$).

Time of Setting. 3. (*a*) *Grade Q.*—Shall set in not less than 2 nor more than 4 minutes.

(*b*) *Grade M.*—Shall set in not less than 6 nor more than 12 minutes.

(*c*) *Grade S.*—Shall set in not less than 20 nor more than 30 minutes.

Tensile Strength. 4. The calcined gypsum, when tested in accordance with the requirements of Section 9, shall have a tensile strength of not less than 300 lb. per sq. in.

Fineness. 5. The calcined gypsum shall all pass a No. 30 sieve and not less than 95 per cent shall pass a No. 100 sieve.

Condition. 6. The calcined gypsum shall be dry and free from lumps.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. H. J. Schweim, Secretary of Committee C-11 on Gypsum, United States Gypsum Co., 300 W. Adams St., Chicago, Ill.

SAMPLING

Sampling.

7. At least 3 per cent of the packages shall be sampled and shall be so selected as to be representative of the contents of the shipment. Samples shall be taken from both the surface and the center of each package so selected. The material so obtained shall be thoroughly mixed and reduced by quartering to provide not less than a 15-lb. (6.75 kg.) sample for the laboratory.

Laboratory Samples.

8. All laboratory samples shall immediately be placed in an airtight container and shipped to the laboratory for test.

METHODS OF TESTING

Methods of Testing.

9. The chemical and physical properties of calcined gypsum for use in the preparation of dental plasters shall be determined in accordance with the Standard Methods of Testing Gypsum and Gypsum Products (A.S.T.M. Designation: C 26) of the American Society for Testing Materials,[1] except that in the determinations of the time of setting and the tensile strength, the calcined gypsum and water shall soak for 30 seconds in distilled water at 70° F. and shall be mixed in the proportion of 100 g. of calcined gypsum to 60 cc. of water.

PACKING AND MARKING

Packing and Marking.

10. When shipped, the following information shall be legibly marked on each package or on a tag of suitable size attached thereto:

Name of manufacturer;
Brand;
Description;
Net weight of package.

INSPECTION AND REJECTION

Inspection.

11. Inspection may be made either at the point of shipment or at the point of delivery. The inspector representing the purchaser shall have free access to the carrier being loaded for shipment to the purchaser. He shall be afforded all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere unnecessarily with the loading of the carriers.

Rejection.

12. Any rejection shall be based upon the specific cause of failure to conform to the requirements of these specifications and shall be reported within ten working days from the receipt of the shipment by the consignee.

Rehearing.

13. Claim for rehearing shall be valid only if made within 20 working days from receipt of notice of specific cause for rejection.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 94.

TENTATIVE DEFINITIONS OF TERMS RELATING TO THE GYPSUM INDUSTRY[1]

A.S.T.M. Designation: C 11 - 29 T

This is a Tentative Standard, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1916; REVISED, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929.

Aggregate.—Any inert material used as a filler in stucco, plaster, mortar, concrete, etc., without regard to its function as a binding material.

Consistency.—A property of a material determined by the complete flow-force relation.

Gypsum Partition Tile or Block.—A gypsum building unit in form of tile or block for use in non-bearing construction in the interior of buildings and for the protection of columns, elevator shafts, etc., against fire.

NOTE 1.—The words "tile" and "block" are synonymous and are used so as to be in accord with certain freight association nomenclature.

NOTE 2.—Gypsum cored tile, 3 or 4 in. in thickness, may be split and used for furring purposes.

Gypsum Plaster Board.—A sheet composed of an incombustible core of gypsum, surfaced with paper or other fibrous material which is firmly bonded to the core, or with intermediate layers of such material within the core, or an incombustible sheet of gypsum with not more than 15 per cent by weight of fiber intimately mixed; and designed to be used as a lath for the reception of gypsum plaster.

Gypsum Wall Board.—A sheet composed of an incombustible core of gypsum, surfaced with paper or other fibrous material which is firmly bonded to the core, and designed to be used, without the addition of plaster, for walls, ceilings or partitions and affording a surface suitable to receive decoration.

Plasticity.—A complex property of a material, involving a combination of the properties of mobility and of yield value.

NOTE.—A plastic material is distinct from a solid material in that it possesses mobility. It is distinct from a fluid material in that it requires a measurable force (yield value) to start flow.

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[1] Criticisms of these Tentative Definitions are solicited and should be directed to Mr. H. J. Schweim, Secretary of Committee C-11 on Gypsum, United States Gypsum Co., 300 W. Adams St., Chicago, Ill.

These Definitions, when adopted as standard, will be added to the present Standard Definitions of Terms Relating to the Gypsum Industry (A.S.T.M. Designation: C 11 - 28), 1928 Supplement to Book of A.S.T.M. Standards, p. 92.

TENTATIVE SPECIFICATIONS
FOR
PAVING BRICK[1]

A.S.T.M. Designation: C 7 – 29 T

This is a Tentative Standard, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1927; REVISED, 1928, 1929.

Scope. 1. These specifications cover vitrified brick used in the construction of pavements.

Basis of Purchase. 2. The consumer or purchaser shall specify the size or sizes and variety or varities of brick which are to be supplied.

NOTE.—The sizes and varieties recognized by the Permanent Committee on Simplification of Varieties and Standards for Vitrified Paving Brick of the U. S. Department of Commerce given below are recommended for use wherever practicable:

	DEPTH, IN.	WIDTH, IN.	LENGTH, IN.
Plain Wire-Cut (vertical fiber lugless as usually laid)	$2\frac{1}{2}$	4	$8\frac{1}{2}$
	3	4	$8\frac{1}{2}$
	$3\frac{1}{2}$	4	$8\frac{1}{2}$
Wire-Cut Lug (Dunn)	3	$3\frac{1}{2}$	$8\frac{1}{2}$
	4	$3\frac{1}{2}$	$8\frac{1}{2}$
Repressed Lug	4	$3\frac{1}{2}$	$8\frac{1}{2}$

The above sizes and varieties are those recognized by the Permanent Committee for the year 1929, and are subject to change from year to year.

MANUFACTURE

General Requirements. 3. Paving brick shall be manufactured from fire clay, semi-fire clay or shale, or combinations thereof. The manufacturing process shall be such that the brick are thoroughly annealed, tough, durable and evenly burned so that, when broken, they show a uniformly dense structure free from lime, air pockets and marked laminations.

Lug Brick. 4. Lug brick shall be provided with not less than two lugs on one side of the brick. The lugs shall project not less than $\frac{1}{8}$ in. nor more than $\frac{1}{4}$ in. from the side of the brick and the total area of contact of the lugs shall not exceed 30 per cent of the area of the side of the brick.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. J. W. McBurney, Secretary of Committee C-3 on Brick, U. S. Bureau of Standards, Washington, D. C.

These tentative specifications are in effect a revision of the former Standard Specifications for Paving Brick (A.S.T.M. Designation: C 7 – 15) which specifications were discontinued in 1929.

Beveled-End Brick. 5. Beveled-end brick shall be double-beveled not more than $\frac{1}{8}$ in. on each end.

Repressed Brick. 6. The edges of repressed brick shall be rounded to a radius of not more than $\frac{3}{16}$ in.

Size. 7. Paving brick shall conform to the following nominal sizes. The dimensions of the brick shall be construed as applying to the body of the brick only, exclusive of lugs or beveled ends:

TRANSVERSE DIMENSIONS, IN.	LENGTH, IN
2½ by 4	8½
3 by 3½	8½
3 by 4	8½
3½ by 4	8½

Permissible Variations in Size. 8. For any lot of paving brick furnished under these specifications, the individual bricks shall not vary from the nominal size requirements specified in Section 7 by more than ± $\frac{1}{8}$ in. in either transverse dimension, or by more than ± $\frac{1}{4}$ in. in length.

PHYSICAL PROPERTIES AND TESTS

9. The quality and acceptability of paving brick shall be determined by the rattler test as described in Sections 17 to 29, inclusive, and by visual inspection, as described in Section 16. The acceptance of paving brick as satisfactorily meeting either of these tests shall not be construed as in any way waiving the other.

Percentage of Loss. 10. The percentage of loss in the rattler test of the respective sizes of paving brick specified shall conform to the following maximum requirements:

SIZE OF BRICK TRANSVERSE DIMENSIONS, IN.	LENGTH, IN.	LOSS IN RATTLER TEST PER CENT
2½ by 4	8½	26
3 by 3½	8½	26
3 by 4	8½	24
3½ by 4	8½	22

SAMPLING

Standard Sample. 11. The standard sample for the rattler test shall consist of ten whole undamaged brick which conform individually to the visual inspection requirements specified in Section 16.

Selection of Sample.

12. (*a*) Samples shall preferably be selected at the place of manufacture and tested prior to shipment. However, in special cases where less than 100,000 brick are involved, samples, when required, may be selected subsequent to delivery at the destination.

Number of Standard Samples.

(*b*) In general, one standard sample shall be selected for each 15,000 brick or fraction thereof; provided, however, that when the sampling is done at the place of manufacture prior to shipment and the total number of brick involved is more than 100,000 brick, the number of brick for which one standard sample is considered representative may be increased at the option of the purchaser to not more than 50,000 brick.

Basis of Acceptance.

13. Acceptance of any lot of paving brick shall be based on the results of the rattler test on the sample representing that lot, subject only to rejection at any time of individually imperfect or unsatisfactory brick, in accordance with the requirements under Visual Inspection as described in Section 16.

Retesting.

14. (*a*) If the percentage of loss on any sample exceeds by 2 per cent or less the maximum permissible rattler loss specified in Section 10 for the size specified, the lot shall not be rejected but two additional tests shall be made and if the average of the three tests equals or is less than the maximum permissible rattler loss, the entire lot shall be accepted, provided no test used in computing the average of the three tests exceeds the maximum permissible rattler loss by more than 2 per cent.

(*b*) *Rejection* —Where a lot of paving brick is rejected for failure to pass the rattler test, the purchaser may, at his option, permit the seller to regrade the rejected brick and again offer the brick for test and acceptance. The regraded brick shall be resampled and retested and if it again fails, the purchaser may definitely and finally reject the lot for which the test is representative.

Payment for Cost of Testing.

15. Unless otherwise specified, the seller shall furnish at the place of manufacture, without charge to the purchaser, the use of an approved rattler, in efficient operating condition, conforming to the requirements specified in Sections 17 to 25, inclusive. Payment of the cost of testing shall be made by the purchaser, except that the cost of testing additional samples in accordance with Section 14, made necessary by the failure of any lot or lots, or of testing supplemental samples to determine the admissibility of a portion of any lot or lots, shall be paid by the seller. Provided, however, that if the supplemental tests show the brick under examination to be acceptable, then the cost of such tests shall be paid by the purchaser.

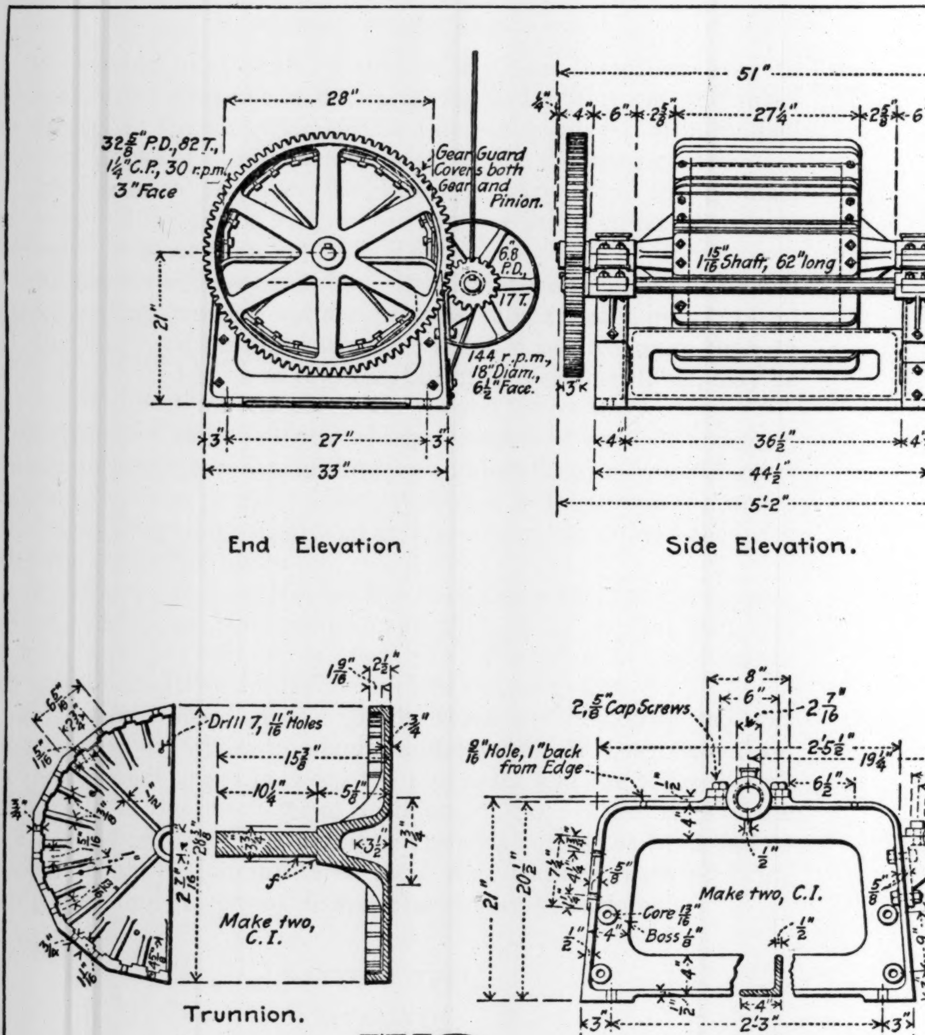
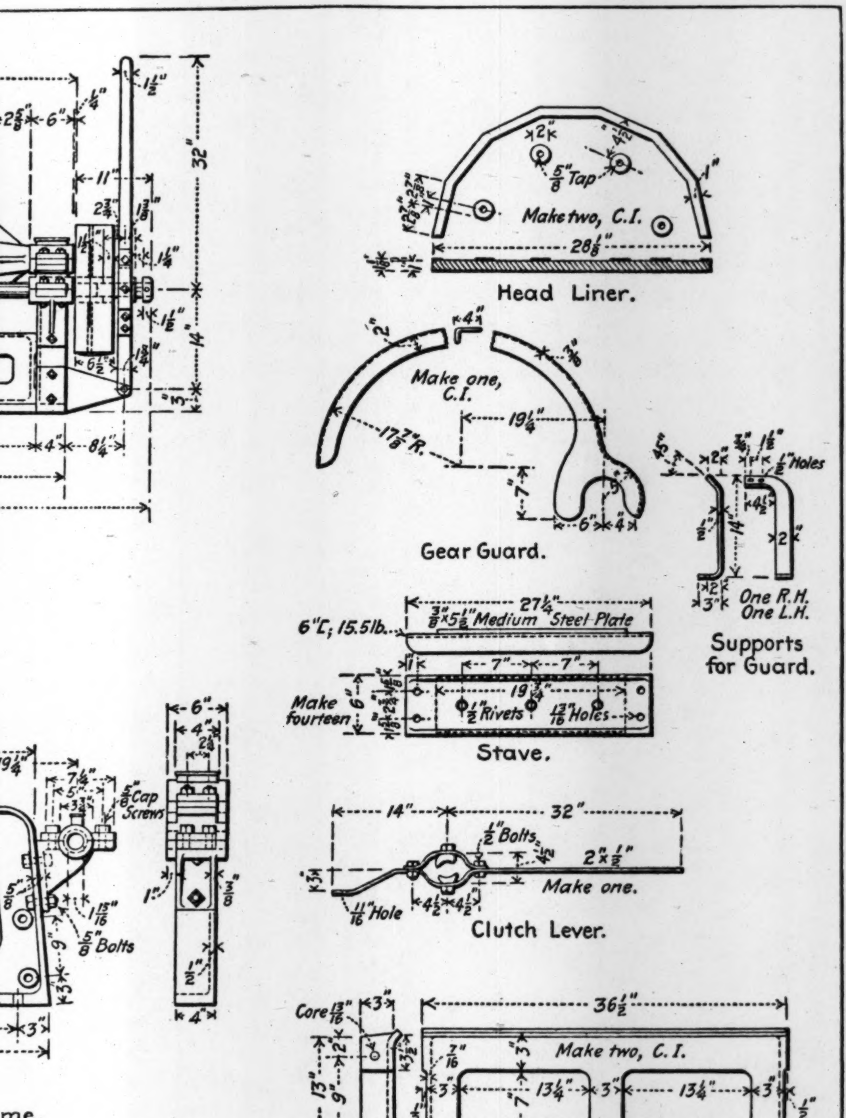

28"
32 5/8" P.D., 82 T., 1 1/4" C.P., 30 r.p.m., 3" Face
Gear Guard Covers both Gear and Pinion.
6.8" P.D., 17 T.
144 r.p.m., 18" Diam., 6 1/2" Face.
21"
3"
27"
3"
33"
End Elevation
51"
1/4"
4"
6"
2 5/8"
27 1/4"
2 5/8"
1 15/16" Shaft, 62" long
3"
4"
36 1/2"
44 1/2"
5'-2"
Side Elevation.
1 9/16"
2 1/2"
Drill 7, 11/16" Holes
15 3/8"
10 1/4"
5 1/8"
3/4"
7 3/4"
3 1/2"
f
28 1/8"
2 7/16"
Make two, C.I.
Trunnion.
1 7/8"
225 required.
3 3/4"
75 required.
Spherical Shot.
8"
6"
2, 5/8" Cap Screws
2 7/16"
9/16" Hole, 1" back from Edge
2'-5 1/2"
19 1/4"
6 1/2"
1/2"
4"
21"
20 1/2"
Make two, C.I.
Core 13/16"
Boss 1/8"
4"
3"
2'-3"
3"
2'-9"
End Frame.

FIG. 1.—Details of Rattler fo

PLATE VIII.
PROC. AM. SOC. TESTING MATS., VOL. 29, PART I.

TENTATIVE SPECIFICATIONS FOR PAVING BRICK.



32"
14"
11"
6"
4"
8¼"
6½"
5/8" Cap Screws
5/8" Bolts
6"
4"
Make two, C.I.
28⅛"
5/8" Tap
Head Liner.
Make one, C.I.
19¼"
17⅞" R.
Gear Guard.
½" Holes
One R.H.
One L.H.
Supports for Guard.
27¼"
6" [; 15.5 lb.
⅜"×5½" Medium Steel Plate
Make fourteen
½" Rivets
13/16" Holes
7"
19¾"
Stave.
14"
32"
½" Bolts
2"×½"
Make one.
11/16" Hole
4½"
Clutch Lever.
Core 13/16"
36½"
Make two, C.I.
13¼"
Side Frame.
me.

tler for Testing Brick.

VISUAL INSPECTION

Rejection by Visual Inspection.

16. Paving brick shall be subject to visual inspection prior to shipment, after delivery, or during laying and culling out and rejection subject to the exception specified in Paragraph (*b*), of individual imperfect bricks or unsatisfactory brick for the following causes:

(*a*) *Variation in Size.*—Brick which vary from the nominal sizes specified in Section 7 by more than $\pm\frac{1}{8}$ in. in either transverse dimension, or more than $\pm\frac{1}{4}$ in. in length.

(*b*) *Broken or Chipped Brick.*—Brick which are chipped or broken so that neither wearing surface remains substantially intact, or so that the lower, or bearing surface, is reduced in area more than 15 per cent, provided brick so rejected, but otherwise acceptable, may be used for half-brick for beginning courses and for batting.

(*c*) *Cracked Brick.*—Brick which are cracked to such a degree, either from shocks received in shipping and handling, or from defective manufacture, as to produce defects described in Paragraph (*b*), unless such cracks are plainly superficial and insufficient to weaken the brick under the conditions of use.

(*d*) *Warped or Kiln-Marked Brick.*—Brick which are mis-shaped, bent or twisted, or kiln-marked more than $\frac{3}{16}$ in. so that they will not form a proper surface, or align with other brick in conformance with the specifications for laying brick in the pavement.

(*e*) *Under-Burned Brick.*—Brick which are obviously too soft and too poorly vitrified to endure traffic wear. If disagreement on this requirement arises between the purchaser and the seller it shall be the right of the purchaser to make one or more rattler tests of the brick he wishes to exclude, and if in any or all tests the brick fail to conform to the requirements of these specifications, then all brick having the same objectionable appearance may be excluded.

RATTLER TEST

APPARATUS

Apparatus.

17. The machine used in the rattler test shall be of good mechanical construction, self-contained, and shall conform to the following details of material and dimensions, and shall consist of barrel, frame and driving mechanism as described in Sections 18 to 22. In Fig. 1 (Plate VIII) is illustrated a rattler which will meet the requirements specified, and to which reference should be made.

Barrel.

18. The barrel of the machine shall consist of the heads, head-liners, staves, and stave-liners conforming to the following requirements:

(*a*) *Heads.*—The heads may be cast in one piece with the trunnions which shall be $2\frac{7}{16}$ in. in diameter, and shall have a bearing 6 in. in length; or they may be cast with heavy hubs, which shall be bored out for $2\frac{7}{16}$ in. shafts and shall be key-seated for two keys, each $\frac{1}{2}$ by $\frac{3}{8}$ in. and spaced 90 deg. apart. The shaft shall be a snug fit and when keyed shall be entirely free from lost motion. The distance from the end of the shaft or trunnion to the inside face of the head shall be $15\frac{3}{8}$ in. in the head for the driving end of the rattler and $11\frac{3}{8}$ in. for the other head, and the distance from the face of the hubs to the inside face of the heads shall be $5\frac{1}{8}$ in.

The heads shall not be less than $\frac{3}{4}$ nor more than $\frac{7}{8}$ in. in thickness. In outline, each head shall be a regular 14-sided polygon inscribed in a circle $28\frac{3}{8}$ in. in diameter. Each head shall be provided with flanges not less than $\frac{3}{4}$ in. in thickness and extending outward $2\frac{1}{2}$ in. from the inside face of the head to afford a means of fastening the staves. The surface of the flanges of the head shall be smooth and give a true and uniform bearing for the staves. To secure the desired true and uniform bearing, the surfaces of the flanges of the head shall be either ground or machined. The flanges shall be slotted on the outer edge, so as to provide for two $\frac{3}{4}$-in. bolts at each end of each stave, the slots to be $\frac{13}{16}$ in. in width and $2\frac{3}{4}$ in. center to center. Each slot shall be provided with a recess for the bolt head, which shall act to prevent the turning of the same. Between each two slots there shall be a brace $\frac{3}{8}$ in. in thickness extending down the outward side of the head not less than 2 in.

(*b*) *Headliners.*—There shall be for each head a cast-iron headliner, 1 in. in thickness and conforming to the outline of the head, but inscribed in a circle $28\frac{1}{8}$ in. in diameter. This headliner shall be fastened to the head by seven $\frac{5}{8}$-in. cap screws, through the head from the outside. Whenever these headliners become worn down $\frac{1}{2}$ in. below their initial surface level, at any point of their surface, they shall be replaced with new ones. The metal of these headliners shall be hard machinery iron and should contain not less than 1 per cent of combined carbon.

(*c*) *Staves.*—The staves shall be made of 6-in. medium-carbon steel structural channels $27\frac{1}{4}$ in. in length and weighing 15.5 lb. per lineal foot. The staves shall have two holes $\frac{13}{16}$ in. in diameter, drilled in each end, the center line of the holes being 1 in. from the end and $1\frac{3}{8}$ in. either way from the longitudinal center line. The spaces between the staves shall be as uniform as practicable, but shall not exceed $\frac{5}{16}$ in.

(*d*) *Staveliners.*—The interior or flat side of each stave shall be protected by a liner $\frac{3}{8}$ in. thick by $5\frac{1}{2}$ in. wide by $19\frac{3}{4}$ in. long. The liner shall consist of medium-carbon steel plate, and shall be riveted to the channel by three $\frac{1}{2}$-in. rivets, one of which shall be on the center line both ways and the other two on the longitudinal center line and spaced 7 in. from the center each way. The rivet holes shall be counter-sunk on the face of the liner and the rivets shall be driven hot and chipped off flush with the surface of the liners. These liners shall be inspected from time to time, and if found loose shall be at once re-riveted.

Preliminary Operation.

19. When a new rattler, in which a complete set of new staves is furnished, is first put into operation, it shall be charged with 400 lb. of shot of the same sizes, and in the same proportion as provided in Section 23, and shall then be run for 18,000 revolutions at the rate of speed specified in Section 27(*a*). The shot shall then be removed and a standard shot charge inserted after which the rattler may be charged with brick for a test.

Relining.

20. No stave shall be used for more than 70 consecutive tests without renewing its lining. Two of the 14 staves shall be removed and relined at a time in such a way that of each pair, one falls upon one side of the barrel and the other upon the opposite side, and also so that the staves changed shall be consecutive, but not contiguous: for example, 1 and 8, 3 and 10, 5 and 12, 7 and 14, 2 and 9, 4 and 11, 6 and 13, etc., to the end that the interior of the barrel at all times shall present the same relative conditions of repair. The changes in the staves should be made at the time when the shot charges are being corrected, and the record must show the number of charges run since the last pair of new lined staves was placed in position.

The staves when bolted to the heads shall form a barrel 20 in. in length, inside measurement, between headliners. The liners of the staves shall be so placed as to drop between the headliners. The staves shall be bolted tightly to the heads by four $\frac{3}{4}$-in. bolts and each bolt shall be provided with a locknut and shall be inspected at not less frequent intervals than every fifth test and all nuts kept tight. A record shall be made after each inspection showing in what condition the bolts were found.

Barrel Frame.

21. The barrel shall be mounted on a cast-iron frame of sufficient strength and rigidity to support it without undue vibration. It shall rest on a rigid foundation with or without the interposition of wooden plates, and shall be fastened thereto by bolts at not less than four points.

Driving Mechanism.

22. The barrel shall be driven by gearing whose ratio of driver to driven is not less than one to four. The counter shaft upon which

the driving pinion is mounted shall not be less than $1\frac{15}{16}$ in. in diameter, with bearing not less than 6 in. in length. If a belt drive is used, the pulley shall be not less than 18 in. in diameter and $6\frac{1}{2}$ in. in face. A belt at least 6 in. in width, properly adjusted, to avoid unnecessary slipping, should be used.

Abrasive Charge.

23. The abrasive charge shall consist of cast-iron spheres of two sizes.

(*a*) *Large Spheres.*—When new, the larger spheres shall be 3.75 in. in diameter and shall weigh approximately 7.5 lb. (3.40 kg.) each. Ten spheres of this size shall be used. These shall be weighed separately after each ten tests, and if the weight of any large sphere falls to 7 lb. (3.175 kg.) it shall be discarded and a new one substituted; provided, however, that all of the large spheres shall not be discarded and substituted by new ones at any single time, and that in so far as possible the large spheres shall compose a graduated series in various stages of wear.

(*b*) *Small Spheres.*—When new, the smaller spheres shall be 1.875 in. in diameter and shall weigh approximately 0.95 lb. (0.43 kg.) each. In general, the number of small spheres in a charge shall not fall below 245 nor exceed 260. The collective weight of the large and small spheres shall be as nearly 300 lb. as possible. No small sphere shall be retained in use after it has been worn down so that it will pass a circular hole 1.75 in. in diameter, drilled in an iron plate $\frac{1}{4}$ in. in thickness, or weigh less than 0.75 lb. (0.34 kg.).

Further, the small spheres shall be tested by passing them over the plate mentioned or by weighing, after every ten tests, and any which pass through or fall below the specified weight, shall be replaced by new spheres, provided, further, that all of the small spheres shall not be rejected and replaced by new ones at any one time, and that so far as possible the small spheres shall compose a graduated series in various stages of wear. At any time that any sphere is found to be broken or defective it shall at once be replaced.

Chemical Composition of Charge.

24. The cast-iron abrasive spheres shall conform to the following requirements as to chemical composition:

Combined carbon	Not under	2.50 per cent
Graphitic carbon	" over	0.25 "
Silicon	" "	1.00 "
Manganese	" "	0.50 "
Phosphorus	" "	0.25 "
Sulfur	" "	0.08 "

For each new batch of spheres used, the chemical analysis shall be furnished by the maker or be obtained by the user, before introducing the spheres into the charge, and unless the analysis conforms to the requirements specified, the batch of spheres shall be rejected.

25. The scales used shall be placed on a solid level foundation and shall be sufficiently sensitive to determine the initial weight of 10 bricks to the nearest 0.1 lb. The scale shall be tested by a standard test weight at intervals of not more than every ten tests. **Scales.**

TEST SPECIMEN

26. The number of brick per test shall be ten whole bricks for all weights of brick, and the brick shall be weighed to the nearest 0.1 lb. No brick should be selected as part of a regular test that would be rejected by any other requirements of the specifications under which the purchase is made. **Test Specimen.**

PROCEDURE

27. (*a*) The test shall consist of 1800 revolutions of the rattler at the rate of not less than 29.5 nor more than 30.5 revolutions per minute. A counting machine shall be attached to the rattler for counting the revolutions. A margin not to exceed ten revolutions will be allowed for starting and stopping. Only one start and stop per test is, in general, acceptable. If, from accidental causes, the rattler is stopped and started more than once during a test, and the percentage loss exceeds the maximum permissible under the specifications, the test shall be disqualified and another made. **Procedure.**

(*b*) Any test, at the expiration of which a stave-liner is found detached from the stave or seriously out of position, shall be rejected.

28. The loss shall be calculated as a percentage of the original weight of the brick composing the charge, by weighing the brick remaining in the rattler at the end of the test, deducting this weight from the original weight of the brick, dividing this difference by the original weight of the brick and multiplying by 100. **Percentage Loss of Weight.**

$$\text{Percentage of Loss} = \frac{\text{Original Weight} - \text{Weight after Testing}}{\text{Original Weight}} \times 100$$

In weighing the rattled brick, any piece weighing less than 1 lb. shall be rejected.

RECORD

29. A complete and continuous record shall be kept of the operation of all rattlers working under the Rattler Test. This record shall contain the following data concerning each test made: **Rattler Record.**

1. The name of the person, firm or corporation furnishing each sample tested.
2. The name of the maker of the brick represented in each sample tested.

3. The name of the street or contract, which the sample represented.
4. The brands or marks upon the bricks by which they were identified.
5. The number of bricks furnished.
6. The date on which they were received for test.
7. The date on which they were tested.
8. The drying treatment given before testing, if any.
9. The length, width and thickness of the bricks.
10. The collective weight of the ten large spherical shot used in making the test at the time of their last standardization.
11. The number and collective weight of the small spherical shot used in making the test at the time of their last standardization.
12. The total weight of the shot charge, after its last standardization.
13. Certificate of the operator that he examined the condition of the machine as to staves, liners, and any other parts affecting the barrel, and found them to conform to the requirements at the beginning of the test.
14. Certificate of the operator of the number of charges tested since the last standardization of shot charge and last renewals of stave liners.
15. The time of the beginning and ending of each test, and the number of revolutions made by the barrel during the test, as shown by the counting machine.
16. Certificate of the operator as to number of stops and starts made in each test.
17. The initial collective weight of the ten brick composing the charge and their collective weight after rattling.
18. The loss calculated as a percentage of the initial weight and the calculation itself, the correction factor, and the corrected percentage of loss.
19. The number of broken bricks and remarks upon the portions which were included in the final weighing.
20. General remarks upon the test and any irregularities occuring in its execution.
21. The certificate of the operator that the test was made in accordance with the requirements of the American Society for Testing Materials and that the record is a true record.
22. The signature of the operator or person responsible for the test.
23. The location of the laboratory where the test was made and name of the owner.
24. The serial number of the test.

In the event of more than one copy of the record of any test being required, they may be furnished on separate sheets and marked duplicate, but the original record shall always be preserved intact and complete.

TENTATIVE SPECIFICATIONS
FOR
DRY BLEACHED SHELLAC[1]

A.S.T.M. Designation: D 207 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. These specifications cover two grades of dry bleached shellac, namely, regular and refined.

NOTE.—Dry bleached shellac is white shellac. It is known as "bone dry," "vacdry" or "kiln-dried" bleached shellac. The refined grade is bleached shellac that has been treated in the process of manufacture so as to remove practically all wax and matter insoluble in hot alcohol.

PROPERTIES AND TESTS

Properties. 2. Dry bleached shellac shall conform to the following requirements:

	REGULAR	REFINED
Iodine number, maximum	10	10
Matter insoluble in hot alcohol, maximum, per cent	1.0	0.2
Moisture, maximum, per cent	5.0	5.0
Wax, maximum, per cent	5.5	0.2
Matter soluble in water, maximum, per cent	1.0	0.3
Ash, maximum, per cent	1.0	0.3

METHODS OF TESTING

Methods of Testing. 3. The sampling and methods of testing shall be conducted in accordance with the Tentative Methods of Sampling and Testing Shellac (A.S.T.M. Designation: D 29 - 29 T) of the American Society for Testing Materials.[2]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

These specifications, when adopted as standard, will supersede the present Standard Specifications for Dry Bleached Shellac (A.S.T.M. Designation: D 207 - 26), 1927 Book of A.S.T.M. Standards, Part II, p. 239.

[2] See p. 655.

TENTATIVE SPECIFICATIONS
FOR
ORANGE SHELLAC[1]

A.S.T.M. Designation: D 237 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. Orange shellacs may, for convenience, be grouped into the following four grades: Grade A, Grade B, Grade C, and Grade D. Stick, seed, garnet and button lacs are not included under these grades.

PROPERTIES AND TESTS

Properties. 2. Orange shellac shall conform to the following requirements:

	GRADE A	GRADE B	GRADE C	GRADE D
Iodine number, maximum	18.0	18.0	18.0	24.3
Matter insoluble in hot alcohol, maximum, per cent	1.75	2.50	3.00	3.00
Moisture, maximum, per cent	2.0	2.0	2.0	2.0
Wax, maximum, per cent	5.5	5.5	5.5	5.5
Matter soluble in water, maximum, per cent.	0.5	0.5	0.5	0.5
Ash, maximum, per cent	1.0	1.0	1.0	1.0
Color	When specified, the color shall be no darker than that of a sample mutually agreed upon by purchaser and seller.[2]			

METHODS OF TESTING

Methods of Testing. 3. The sampling and methods of testing shall be conducted in accordance with the Standard Methods of Sampling and Testing Shellac[2] (A.S.T.M. Designation: D 29 – 29 T) of the American Society for Testing Materials.[3]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

These specifications, when adopted as standard, will supersede the present Standard Specifications for Orange Shellac (A.S.T.M. Designation: D 237 – 27), 1927 Book of A.S.T.M. Standards, Part II, p. 241.

[2] Attention is called to the fact that purchaser and seller must agree upon one of the two methods for determining color appearing in Methods D 29 – 29 T.

[3] See p. 655.

TENTATIVE SPECIFICATIONS AND TESTS
FOR
SOLUBLE NITROCELLULOSE[1]

A.S.T.M. Designation: D 301 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope.

1. These specifications cover the material known as soluble nitrocellulose (also known as soluble cotton), which is shipped wet to conform to the regulations of the Interstate Commerce Commission.

PROPERTIES AND TESTS

Properties and Tests.

2. (*a*) *Appearance.*—The nitrocellulose shall not be discolored and shall be free from lumps and foreign matter, such as charred particles.

(*b*) *Ash.*—The ash content shall not exceed 0.30 per cent, calculated on the basis of dry-weight soluble nitrocellulose.

(*c*) *Nitrogen.*—The percentage of nitrogen, calculated on the basis of dry-weight soluble nitrocellulose, shall be within the limits mutually agreed upon by the buyer and seller for the particular type of soluble nitrocellulose.

(*d*) *Stability.*—The methyl violet test paper shall not be completely changed to a salmon pink color in less than 20 minutes.

(*e*) *Consistency* (*Viscosity*).—The consistency shall be within the limits mutually agreed upon by the buyer and seller for the particular type of soluble nitrocellulose.

(*f*) *Solubility and Appearance of the Solution.*—The solubility and appearance of the sample shall be equal to the standard for the particular type of soluble nitrocellulose.

(*g*) *Film Test.*—The film test of the sample shall be equal to that of the standard for the particular type of soluble nitrocellulose.

(*h*) *Toluol Dilution Test.*—The toluol dilution value of the sample shall be equivalent to that of the standard for the particular type of soluble nitrocellulose.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

METHOD OF SAMPLING

Sampling. 3. Samples shall be taken from two barrels of each lot or batch in the shipment. The composite sample representing a single barrel shall be obtained by taking two samples of approximately 1 pt. each from two well-separated points at least 1 ft. beneath the surface of the material in the barrel. Each barrel sampled shall be tested and reported separately.

METHODS OF TESTING

ASH

Procedure. 4. The percentage of ash shall be determined as follows:

Weigh approximately 2 g. of the sample in a crucible and heat at 50° C. to constant weight (about 15 hours usually suffices). Determine the dry weight of the sample. Moisten the residue with 20 to 30 drops of c.p. nitric acid and heat on a steam bath until the sample is decomposed to a gummy mass. If necessary to complete the decomposition, add several additional drops of nitric acid at intervals. Then heat the crucible slowly over a bunsen burner or in an electric furnace until all volatile matter is driven off. Finally, ignite at red heat to constant weight, cool and weigh.

$$\text{Percentage of ash} = \frac{\text{Wt. of ash}}{\text{Wt. of dry sample}} \times 100$$

NITROGEN

Apparatus. 5. Use the duPont nitrometer[1] which is illustrated in Figs. 1 to 4. Figure 2 (*b*) shows the universal measuring tube, although the nitrocellulose measuring tube shown in Fig. 2 (*a*) is preferable for testing nitrocellulose. If desired, both measuring tubes may be included in the assembly, by replacing the 3-way glass manifold with a 4-way manifold.

Procedure. 6. The percentage of nitrogen shall be determined as follows:

NOTE.—The cellulose acetate mask must be worn during the generation and measurement of the gas as a precaution in case of an explosion.

Accurately calibrate the measuring tube in the usual manner, using mercury as the calibrating liquid.

Standardize the apparatus, using potassium nitrate. Fill the compensating, measuring and reaction tubes and their connections with mercury. Run 20 to 30 cc. of 95 ± 1 per cent c.p. sulfuric acid (sp. gr. 1.84) into the reaction bulb through the cup at the top and let in about 210 cc. of air. Close the stopcocks and shake the bulb well. This desiccates the air, which is then run into the compensating tube until the mercury is about on a level with the 12.50-per-cent mark on the measuring tube, the two tubes being held at the same height. Dissolve 1 g. of potassium nitrate in 2 to 4 cc. of water, introduce into the reaction bulb and wash the cup with 25 to 26 cc. of 95 ± 1 per cent c.p. sulfuric acid (sp. gr. 1.84) in 3 or 4 portions, each portion being run separately into the bulb. When the reaction is completed, run the gas over into the measuring tube, so that the mercury in the measuring tube is also at the 13.86-per-cent mark, (the theoretical percentage of nitrogen in potassium nitrate). Paste a

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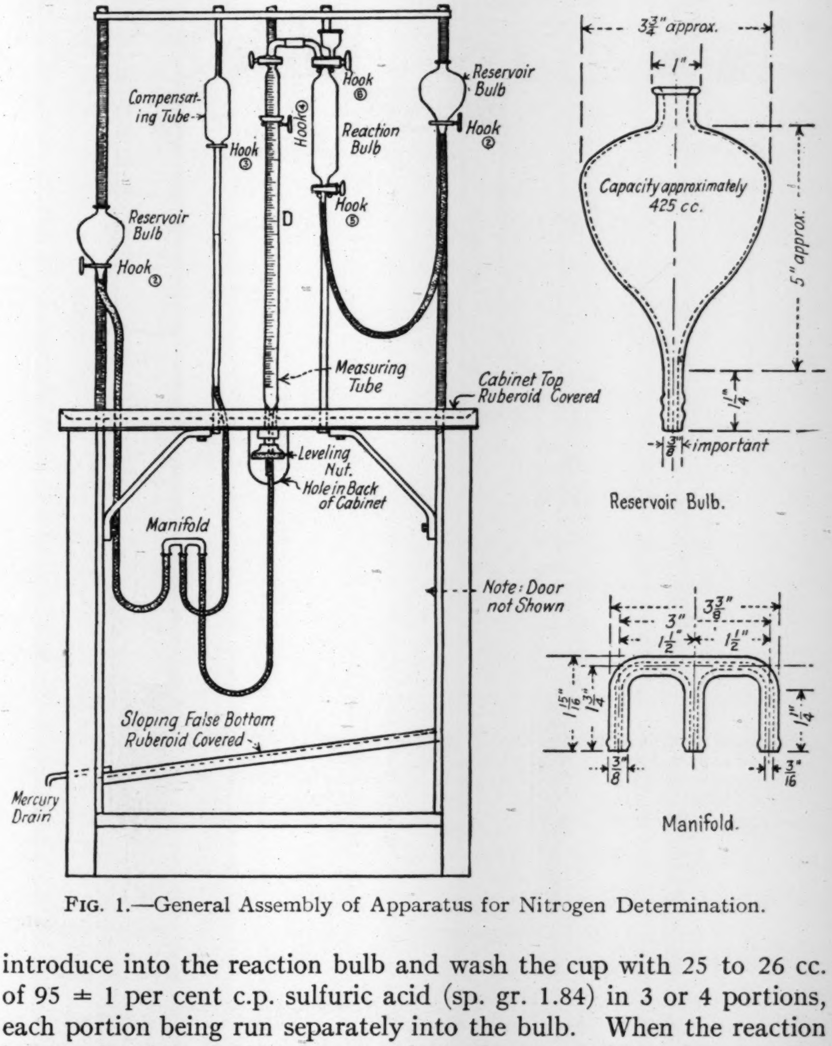
[1] Drawings reproduced by permission from the Standard Specifications for Laboratory Apparatus Adopted by the Manufacturing Chemists' Association of the United States, Part I.

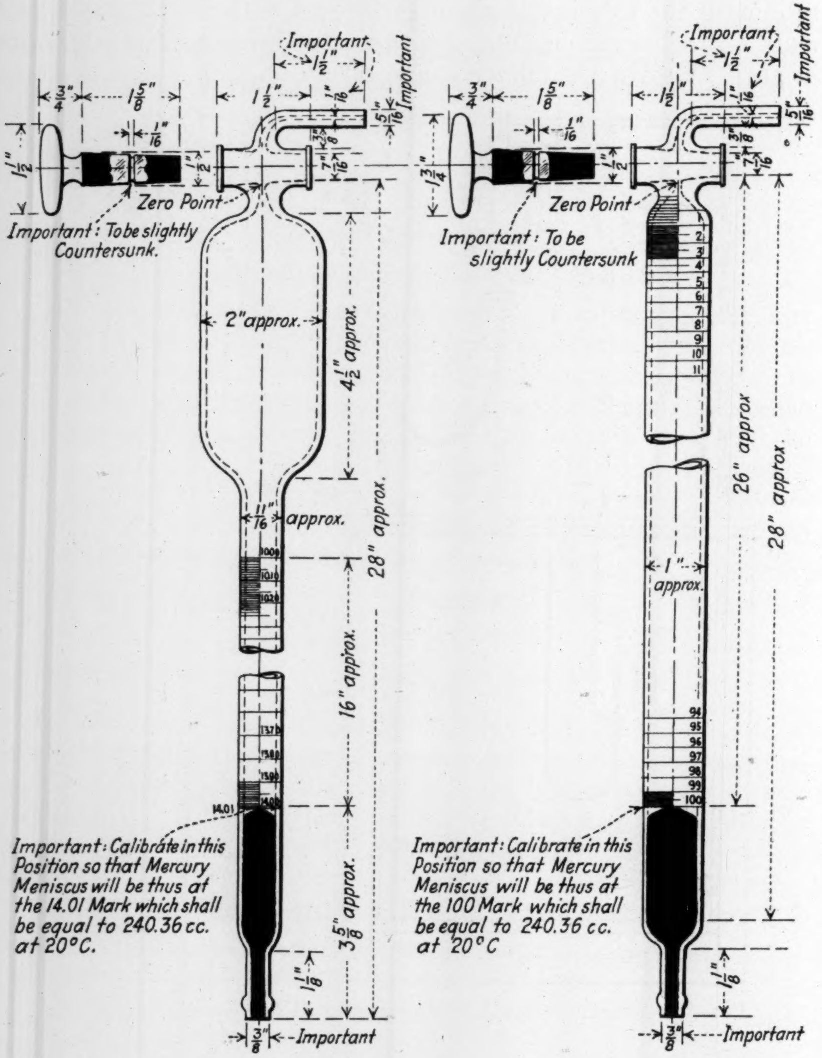

Compensating Tube
Hook ③
Hook ④
Hook ⑥
Reaction Bulb
Reservoir Bulb
Hook ②
Hook ⑤
Reservoir Bulb
Hook ①
D
Measuring Tube
Cabinet Top Ruberoid Covered
Leveling Nut.
Hole in Back of Cabinet
Manifold
Note: Door not Shown
Sloping False Bottom Ruberoid Covered
Mercury Drain
3¾" approx.
1"
Capacity approximately 425 cc.
5" approx.
1¼"
⅜" important
3⅜"
3"
1½"
1½"
1$\frac{5}{16}$"
1¼"
1¼"
⅜"
$\frac{3}{16}$"

Reservoir Bulb.

Manifold.

FIG. 1.—General Assembly of Apparatus for Nitrogen Determination.

strip of paper on the compensating tube at the level of the mercury and the standardization is completed.


Important
1½"
3/4"
1 5/8"
1/16"
1½"
1"/16
Important
5"/16
3"/8
7"/16
1½"
1"/2
Zero Point
Important: To be slightly Countersunk.
2" approx.
4½" approx.
11"/16 approx.
28" approx.
1000
1010
1020
16" approx.
1370
1380
1390
1400
14.01
Important: Calibrate in this Position so that Mercury Meniscus will be thus at the 14.01 Mark which shall be equal to 240.36 cc. at 20°C.
3 5/8" approx.
1 1/8"
3/8"
Important
Important
1½"
1"/16
Important
3/4"
1 5/8"
1/16"
1½"
5"/16
3"/8
7"/16
1"/2
1 3/4"
Zero Point
Important: To be slightly Countersunk
2
3
4
5
6
7
8
9
10
11
1" approx.
26" approx.
28" approx.
94
95
96
97
98
99
100
Important: Calibrate in this Position so that Mercury Meniscus will be thus at the 100 Mark which shall be equal to 240.36 cc. at 20°C
1 1/8"
3/8"
Important

(*a*) Nitrocellulose tube. (*b*) Universal tube.

FIG. 2.—Measuring Tubes for Nitrogen Determination.

Roughly dry the soluble nitrocellulose at 50° C. and weigh a sample of from 1.0 to 1.05 g. in a weighing bottle. Dry to constant weight at 50° C. (about 15 hours usually suffices). Transfer to the cup of the reaction bulb of the nitrometer; then, using the same lot of sulfuric acid that was employed to standardize the apparatus, dissolve the sample, withdraw into the reaction bulb and rinse the cup into the bulb several times. Use a total of from 25 to 26 cc. of acid for dissolving and rinsing. During this operation allow the bottom stopcock of the reaction bulb to remain open. Then, with the bottom stopcock still open, lower the reservoir bulb to give reduced pressure in the reaction bulb and gently shake the reaction bulb to start

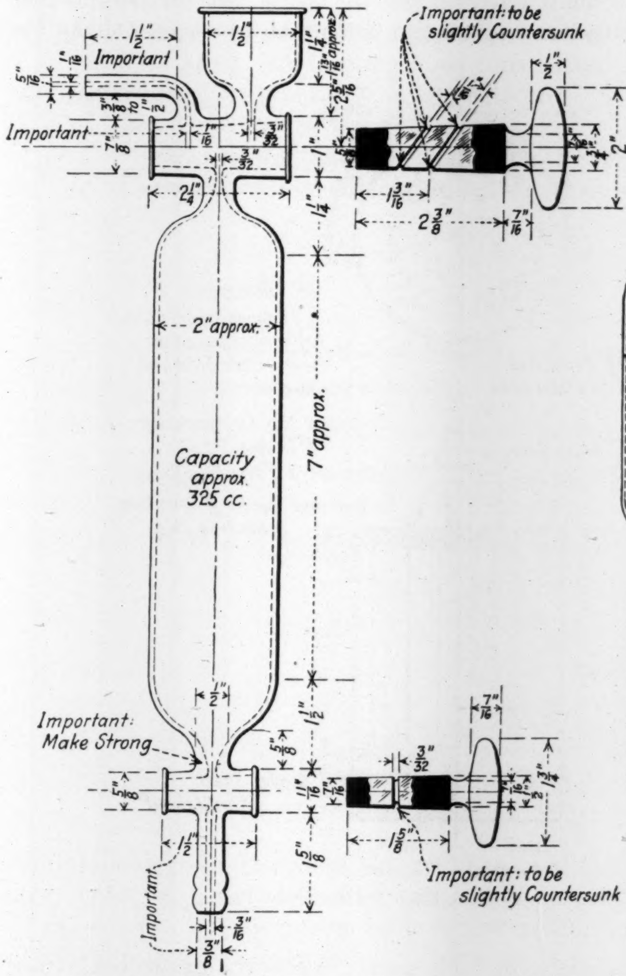

Important
Important
Important: to be slightly Countersunk
2"approx.
Capacity approx. 325 cc.
7"approx.
Important: Make Strong
Important
Important: to be slightly Countersunk
2 3/8"
1 3/16"
1 5/8"

FIG. 3.—Reaction Bulb.

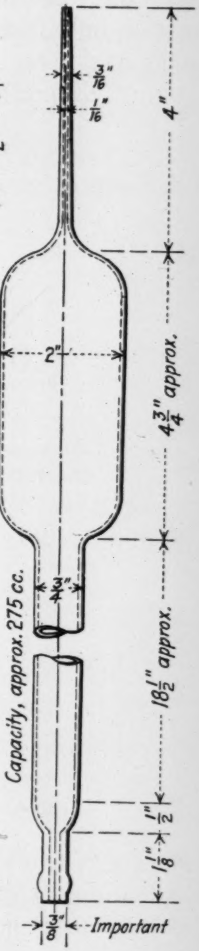

4"
2"
4 3/4" approx.
3/4"
Capacity, approx. 275 cc.
18 1/2" approx.
3/8"
Important

FIG. 4.—Compensating Tube.

the decomposition. After the evolution of nitrous oxide has become slow (it is extremely important that the bottom stopcock be left open until the major part of the decomposition has occurred; otherwise, sudden evolution of gas will burst the bulb, scattering acid and glass), lower the reservoir bulb until all but 25 cc. of the mercury in the reaction bulb is withdrawn, close the bottom stopcock and shake the reaction bulb vigorously for 5 minutes. Allow the gas to cool, transfer to the measuring tube, adjust the levels in the measuring and compensating tubes and take the reading.

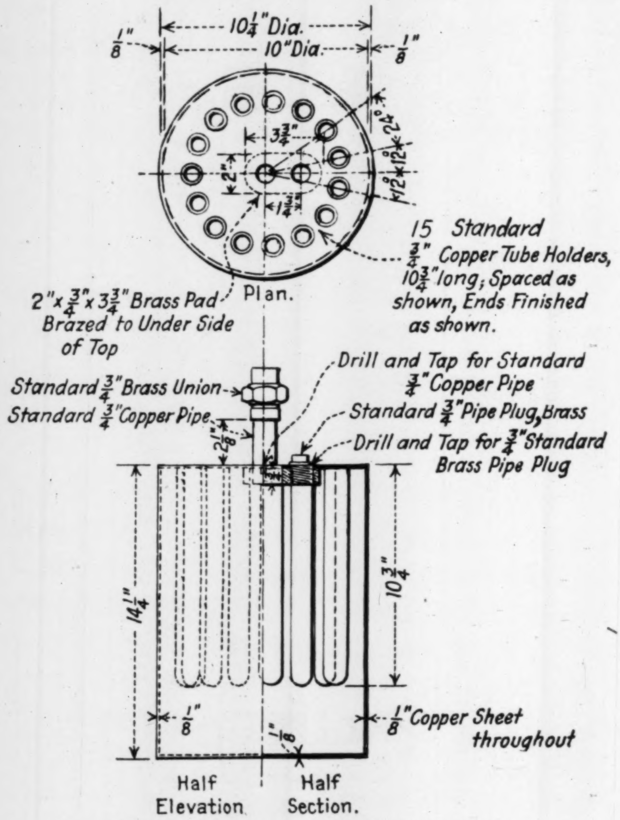

10¼" Dia.
1/8"
10" Dia.
1/8"
3¾"
2"
1¾"
24°
12°
12°
15 Standard ¾" Copper Tube Holders, 10¾" long, Spaced as shown, Ends Finished as shown.
2"x¾"x3¾" Brass Pad Brazed to Under Side of Top
Plan.
Drill and Tap for Standard ¾" Copper Pipe
Standard ¾" Brass Union
Standard ¾" Copper Pipe
2⅛"
Standard ¾" Pipe Plug, Brass
Drill and Tap for ¾" Standard Brass Pipe Plug
14¼"
10¾"
1/8"
1/8"
1/8" Copper Sheet throughout
Half Elevation
Half Section.

FIG. 5.—Copper Bath for Stability Test.

STABILITY

Apparatus. 7. The apparatus shall consist of the following:

(a) *Copper Bath.*—Copper bath with copper or brass condenser, as shown in Figs. 5 and 6. These baths are usually made to hold 13 or 15 test tubes.

(*b*) Test Tubes.—Fifteen Pyrex glass test tubes, 290 mm. in length, approximately 15 mm. in inside diameter, and 17 mm. outside diameter.

(*c*) *Heater.*—An electric hot plate for heating the bath.

(*d*) *Face Mask.*—A face mask, so constructed that a heavy piece of clear cellulose-acetate celluloid sheeting protects the face.

(*e*) *Gloves.*—A pair of heavy gloves.

(*f*) *Pincers.*—Long pincers for handling the test tubes.

(*g*) *Thermometer.*—A mercury-filled thermometer graduated in centigrade degrees, the range being 130 to 140° C. in 0.1° C. Diameter, $\frac{5}{16}$ in. ± $\frac{1}{16}$ in.; over-all length, 18 in. ± $\frac{1}{4}$ in.; length of bulb, $2\frac{3}{8}$ in. ± $\frac{1}{4}$ in.; distance from bulb to first graduation, $8\frac{5}{8}$ in. ± $\frac{1}{4}$ in.; distance from lowest graduation to highest graduation, $4\frac{3}{4}$ in. ± $\frac{1}{4}$ in. Solid stem, white enamel back. Graduations to be numbered at 130, 135 and 140° C. The first and each succeeding 0.5° C. line to be longer than the remaining lines. All graduation lines and figures to be etched on the stem clear cut and distinct. Reservoir at the top to accommodate expansion up to 175° C. Accuracy to be within 0.2° C. over entire scale.

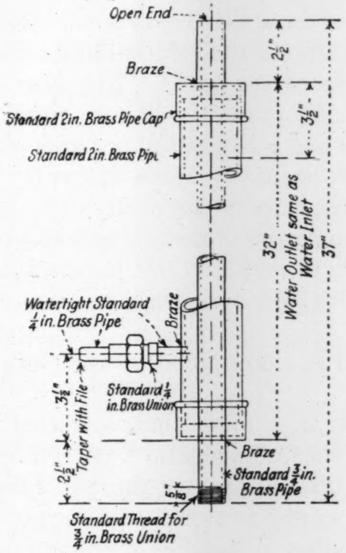

Open End
Braze
Standard 2in. Brass Pipe Cap
Standard 2in. Brass Pipe
$2\frac{1}{2}$"
$3\frac{1}{2}$"
32"
Water Outlet same as Water Inlet
37"
Watertight Standard $\frac{1}{4}$ in. Brass Pipe
Braze
Standard $\frac{1}{4}$ in. Brass Union
$3\frac{1}{2}$"
Taper with File
$2\frac{1}{2}$"
$\frac{5}{8}$
Braze
Standard $\frac{3}{4}$ in. Brass Pipe
Standard Thread for $\frac{3}{4}$ in. Brass Union

FIG. 6.—Brass Condenser for Stability Test Apparatus.

Solution Required.

8. *Methyl Violet Test Paper.*—Conduct the preparation and drying of the methyl violet test paper in a room that is free of acid fumes. Prepare a dye solution according to the following formula:

Basic rosaniline[a] (converted to acetate)	0.2500 g.
Crystal violet	0.1680 g.
C.p. glycerin	6 cc.
Distilled water	30 cc.
95-per-cent ethyl alcohol	sufficient to make-up to 100 cc.

---

[a] The rosaniline acetate used in the foregoing formula is made by adding an excess of glacial acetic acid to 0.2500 g. of basic rosaniline and heating in a porcelain casserole over a steam bath until the excess acid is removed. The other ingredients are then added and volume made up to a total of 100 cc. with 95-per-cent ethyl alcohol.

Place a small quantity of the dye solution into a rectangular glass tray that is supported in a tilted position. Slowly draw a quarter sheet of filter paper through the solution and up and over the side of the dish to remove the excess liquid. The filter paper shall be carefully selected and of such properties as to maintain a permanent color when treated. The S and S No. 597 filter paper gives excellent results. Holding the sheet horizontally, wave it gently back and forth for about one minute, then suspend vertically until dry. When dry, cut into strips 70 by 20 mm. and store in a well-stoppered bottle.

Check each batch of prepared test papers against the papers held as standard by testing the same sample of nitrocellulose with both papers.

Procedure.

9. Stability shall be determined by the German stability test, as follows:

Conduct the test in a room that is free of acid fumes. Dried nitrocellulose is very inflammable and if ignited by fire, spark or static electricity will flare up and shatter the test tube. It is important, therefore, that the operator wear the cellulose acetate mask and heavy gloves and that the tubes be handled with long pincers.

Maintain the heating bath at a temperature of 134.5° C. ± 0.5° C. by the use of the required mixture of xylol and toluol. The proper mixture is approximately one part xylol and four parts toluol, but the exact proportions must be determined by the "cut-and-try" method. If the mixture started with is too high, add more toluol; if it is too low, allow the condenser to run hot until the desired temperature is reached. On continued operation the tendency is for the temperature to rise, which should be corrected by adding toluol.

Weigh accurately 2.5 g. of the sample, previously dried to constant weight at 50° C. (about 15 hours usually suffices). Shake or press the sample down in the test tube so that it occupies the lower two inches of the tube. Suspend a methyl-violet test paper in the tube by a hook made on the end of a glass rod that passes through a cork fitted in the top of the tube. Slit this cork along the side in order to allow for the contraction and expansion of the air in the tube. Suspend the paper so that its lower edge is 1 in. from the top of the sample. Place the tube containing the sample in the heating bath maintained at a temperature of 134.5° C. ± 0.5° C. Beginning at the end of the first ten minutes, inspect the tube at 5-minute intervals by lifting the tube until the methyl violet paper, but not the soluble nitrocellulose, is visible above the surface of the bath. The end point is reached when the test paper completely loses its violet color.

CONSISTENCY, FILM AND TOLUOL DILUTION TESTS

SOLUTIONS REQUIRED

10. The solutions used shall conform to the following formulas: **Solutions Required.**

	FORMULA A	FORMULA B	FORMULA C
Soluble nitrocellulose (dried at 50° C. to constant weight), per cent by weight	12.2	20.0	12.2
Ethyl acetate,[a] per cent by weight	17.5	16.0	....
Denatured alcohol, commercially distilled, No. 1, 188-proof, per cent by weight	22.0	20.0	....
Toluol,[b] per cent by weight	48.3	44.0	....
Normal butyl acetate,[c] per cent by weight	....	....	87.8

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[a] Ethyl acetate conforming to the requirements of the Tentative Specifications for Ethyl Acetate (85 to 88 per cent Grade) (A.S.T.M. Designation: D 302 - 29 T) of the American Society for Testing Materials. See p. 649.

[b] Non-corrosive toluol, 2° C. boiling range, including the boiling point of toluene, 110.7° C.

[c] Normal butyl acetate conforming to the requirements of the Tentative Specifications for Butyl Acetate (85 to 88 per cent Grade) (A.S.T.M. Designation: D 303 - 29 T) of the American Society for Testing Materials. See p. 650.

CONSISTENCY

11. (*a*) *Cylinder.*—A glass cylinder 1 in. in inside diameter, 14 in. in height and with marks on the side at points 2 and 12 in. from the top. **Apparatus.**

(*b*) *Steel Ball.*—A steel ball $\frac{5}{16}$ in. (0.793 mm.) in diameter and weighing 2.046 to 2.054 g.

12. (*a*) *Consistency* (*Viscosity*).—Consistency is determined by putting the soluble nitrocellulose in solution using a standard formula and noting the rate at which a standard steel ball drops through the solution. **Procedure.**

Formula A or B is usually used for determining consistency. Use Formula A unless the sample gives a viscosity with it of 6 seconds or less, in which case use Formula B. Completely dissolve the sample in the solvent mixture by agitating in a tightly-closed container. Fill the glass cylinder with this solution. Allow the cylinder to stand until all air bubbles have passed out of the solution and bring to a temperature of 25° C. ± 0.5° C. Then release the steel ball at the center of the top surface of the solution and allow it to fall through the solution. The number of seconds required for the ball to pass through the 10-in. column of solution between the 2 and 12-in. marks on the cylinder, is recorded as the consistency of the sample.

(*b*) *Report.*—In reporting the consistency prefix the letter A or B to the value of the consistency determined in Paragraph (*a*) in order to indicate the solution formula used.

Solubility and Appearance.

13. *Solubility and Appearance of the Solution.*—Compare either Formula A, B or C (Note) with a freshly-prepared standard solution of the same type of soluble nitrocellulose of the same formula. Make the comparison in small vials and note the color, turbidity, "grain," and "flock."

NOTE.—Formula A or B which was prepared for the consistency determination is ordinarily used. When the soluble nitrocellulose is to be used for purposes requiring extreme transparency and clarity, use Formula C.

FILM TEST

Film Test.

14. Dilute Formula A or B with an equal volume of normal butyl acetate and pour the solution beside a freshly-prepared standard solution, of the same type of soluble nitrocellulose, of the same formula, on a clean glass plate. Allow to dry in a nearly vertical position in a dust-free atmosphere. Compare the sample with the standard for undissolved particles, which indicate un-nitrated cotton or impurities, and for poor flow and poor gloss.

TOLUOL DILUTION TEST

Toluol Dilution Test.

15. To 50 cc. of Formula C in a stoppered bottle, add c.p. toluol (Note) in small quantities from a burette, shaking well after each addition. The first permanent separation of soluble nitrocellulose is taken as the dilution value and is expressed as a percentage by volume of Formula C.

NOTE.—Large quantities of butyl acetate and toluol should be reserved for this test to avoid possible variation between different lots.

TENTATIVE SPECIFICATIONS
FOR
ETHYL ACETATE (85 TO 88 PER CENT GRADE)[1]

A.S.T.M. Designation: D 302 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Properties.

1. Ethyl acetate shall conform to the following requirements:

Specific gravity, 20°/20° C	0.883 to 0.888
Color	water white
Distillation range:	
Below 70° C	none
Below 72° C	not more than 10 per cent
Above 80° C	none
Residue	none
Odor	mild, non-residual
Water	miscible without turbidity with ten volumes of 60° Baumé gasoline
Acidity (free acid as acetic acid)	not more than 0.02 per cent, equivalent to 0.19 mg. KOH per gram of sample
Ester value	85 to 88 per cent by weight

Methods of Testing.

2. The sampling and methods of testing shall be conducted in accordance with the Tentative Methods of Sampling and Testing Lacquer Solvents and Diluents (A.S.T.M. Designation: D 268 – 29 T) of the American Society for Testing Materials.[2]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

[2] See p. 672.

TENTATIVE SPECIFICATIONS
FOR
BUTYL ACETATE (85 TO 88 PER CENT GRADE)[1]

A.S.T.M. Designation: D 303 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Properties. 1. Butyl acetate shall conform to the following requirements:

Specific gravity, 20°/20° C	0.870 to 0.875
Color	water white
Distillation range:	
Below 110° C	none
Below 120° C	not more than 15 per cent
Below 125° C	not less than 70 per cent
Above 145° C	none
Residue	none
Odor	mild, non-residual
Water	miscible without turbidity in all proportions with 60° Baumé gasoline
Acidity (free acid as acetic acid)	not more than 0.03 per cent, equivalent to 0.28 mg. KOH per gram of sample
Ester value	85 to 88 per cent by weight

Methods of Testing. 2. The sampling and methods of testing shall be conducted in accordance with the Tentative Methods of Sampling and Testing Lacquer Solvents and Diluents (A.S.T.M. Designation: D 268 - 29 T) of the American Society for Testing Materials.[2]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

[2] See p. 672.

TENTATIVE SPECIFICATIONS
FOR
BUTANOL (NORMAL BUTYL ALCOHOL)[1]

A.S.T.M. Designation: D 304 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Properties.

1. Butanol (normal butyl alcohol) shall conform to the following requirements:

Purity	98 to 100 per cent of normal butyl alcohol
Specific gravity, 20°/20° C	0.810 to 0.815
Color	water white
Distillation range:	
Between 100 and 118° C	100 per cent
Below 115° C	not more than 10 per cent
Below 105° C	not more than 2 per cent
Residue	none
Odor	mild, non-residual
Water	no cloud when one volume of butanol is mixed with 19 volumes of 60° Baumé gasoline
Acidity (free acid as acetic acid)	not more than 0.03 per cent, equivalent to 0.28 mg. KOH per gram of sample

Methods of Testing.

2. The sampling and methods of testing shall be conducted in accordance with the Tentative Methods of Sampling and Testing Lacquer Solvents and Diluents (A.S.T.M. Designation: D 268 – 29 T) of the American Society for Testing Materials.[2]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

[2] See p. 672.

TENTATIVE METHODS OF TEST
FOR
BLEEDING OF PIGMENTS[1]

A.S.T.M. Designation: D 279 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1928; REVISED, 1929.

METHOD *A:* FOR DRY PIGMENTS TO BE USED IN CELLULOSE ESTER LACQUERS

Procedure.

1. Mix a suitable amount of the pigment to be tested with a minimum volume of dibutyl phthalate to give a thick paste when rubbed up with a sharp-edged steel spatula on a glass plate. Stir this paste into a clear cellulose ester lacquer of a composition mutually agreed upon by the buyer and seller and apply the paint evenly by brushing on a clean, smooth, dry metal panel. Apply the paint to only a part of the panel, leaving a margin of at least 2.5 cm. (1 in.) of unpainted metal around the painted portion. Allow the panel to dry for 30 minutes in a well-ventilated room at room temperature (70 to 90° F.). Flow successive coats of white lacquer of a composition mutually agreed upon by the buyer and seller over the entire surface of the panel until complete hiding is obtained, allowing the panel to dry for 20 minutes in a well-ventilated room at room temperature (70 to 90° F.) after applying each coat. Do not apply any white lacquer after the application of the particular coat that causes complete hiding. Let the completed panel dry for 24 hours and note the color of the two sections of the panel. If the color of the section containing the pigment under test does not match that of the adjoining area containing only the white lacquer, report the pigment as "bleeding."

METHOD B. FOR DRY PIGMENTS TO BE USED IN OIL OR OLEO-RESINOUS PAINTS AND ENAMELS:

Procedure.

2. Mix a suitable amount of the material to be tested with a minimum volume of a mixture of the following:

Raw linseed oil (Note 1)	5 parts by volume
Spar varnish (Note 2)	4 parts by volume
Liquid paint drier (Note 3)	1 part by volume

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

NOTES

NOTE 1.—The raw linseed oil shall conform to the requirements of the Standard Specifications for Raw Linseed Oil (A.S.T.M. Designation: D 234) of the American Society for Testing Materials.[1]

NOTE 2.—The spar varnish shall conform to the requirements of the U. S. Government Master Specification for Water-Resisting Spar Varnish (Federal Specifications Board Specification No. 18*b*).

NOTE 3.—The liquid paint drier shall conform to the requirements of the U. S. Government Master Specification for Liquid Paint Drier (Federal Specifications Board Specification No. 20*a*).

Rub up with a sharp-edged steel spatula on a glass plate to obtain a uniformly smooth, stiff paste. Thin with turpentine to give a paint of brushing consistency, and apply evenly by brushing on a clean, smooth, dry metal panel. Apply the paint to only a part of the panel, leaving a margin of at least 2.5 cm. (1 in.) of unpainted metal around the painted portion. Allow the panel to dry for 18 hours in a well-ventilated room at room temperature (70 to 90° F.). Brush a coat of Damar varnish (Damar resin cut in turpentine) over the entire surface of the panel. Report any color, other than that of the Damar varnish on the unpainted portion of the panel, as "bleeding."

METHOD *C:* FOR PASTES IN OIL

Procedure. 3. Mix a suitable amount of the paste to be tested with sufficient liquid paint drier (see Note 3 of Method *B*, above) to give a paint that will dry within 7 hours. Thin the mixture with turpentine to give a paint of brushing consistency. Thoroughly stir the paint, strain through a No. 100 sieve and apply by brushing to a clean, smooth, dry metal panel. Apply the paint to only a part of the panel, leaving a margin of at least 2.5 cm. (1 in.) of unpainted metal around the painted portion. Allow the panel to dry (should not require over 7 hours) in a well-ventilated room at room temperature (70 to 90° F.). After a total of 18 hours of drying under the above conditions, brush a coat of Damar varnish (Damar resin cut in turpentine) over the entire surface of the panel. Report any color, other than that of the Damar varnish on the unpainted portion of the panel, as "bleeding."

METHOD *D:* FOR PASTES IN JAPAN

Procedure. 4. Mix a suitable amount of the paste to be tested with turpentine to give a paint of brushing consistency. Add the turpentine slowly while thoroughly mixing with a sharp-edged steel spatula or paddle. Thoroughly stir this paint, strain through a No. 100 sieve and apply by brushing to a clean, smooth, dry metal panel. Apply the paint to only a part of the panel, leaving a margin of at least 2.5 cm. (1 in.) of unpainted metal around the painted portion. Allow the panel to dry for 5 hours in a well-ventilated room at room temperature (70 to 90° F.). Brush a coat of Damar varnish (Damar resin cut in turpentine) over the entire surface of the panel. Report any color, other than that of the Damar varnish on the unpainted portion of the panel, as "bleeding."

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 99.

TENTATIVE METHODS OF SAMPLING AND TESTING SHELLAC[1]

A.S.T.M. Designation: D 29 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

Issued, 1929.

SAMPLING

General. 1. Only original packages of shellac shall be sampled. Samples, preferably from not less than 10 per cent of the lot, shall be drawn either by hand or by means of a suitable tryer.

Orange Shellac. 2. (*a*) *Free Shellac.*—In sampling "free" shellac approximately double handfuls shall be taken from each bag of shellac selected for sampling. The total amount of shellac taken shall then be reduced by quartering to approximately 2 lb. This quantity shall be ground to pass a No. 20 (840-micron) sieve. Half of this finely-ground sample shall be reserved by the purchaser and the other half used for analysis.

(*b*) *Blocky or Matted Shellac.*—In sampling "blocky" or "matted" (hard) shellac, approximately 1 lb. shall be taken from each bag selected for sampling. The total amount of shellac taken shall be ground to pass a $\frac{1}{4}$-in. sieve and then reduced by quartering to 2 lb. This quantity shall be ground to pass a No. 20 (840-micron) sieve. Half of this finely-divided sample shall be reserved by the purchaser and the other half used for analysis.

Bleached Shellac. 3. (*a*) *Dry Bleached.*—In sampling dry bleached shellac, about 1 lb. shall be taken from different parts of the barrel and finely ground by running through a coffee mill. No attempt shall be made to sieve it. It shall be rapidly mixed and transferred to a mason jar provided with a screw cap and rubber-ring seal. The jar shall be filled not more than two-thirds full, leaving room for a thorough mixing by shaking the contents. It shall be kept in a cool place and tested as promptly as possible. If too warm, the shellac may tend to lump together, in which case the lumps shall be broken up by shaking.

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

These methods, when adopted as standard, will supersede the present Standard Methods of Testing Shellac (D 29 - 25) and Standard Method of Test for Determination of Wax in Shellac ("Machine-Made" and Dry-Bleached Refined Shellac) (D 29 - 28), see 1927 Book of A.S.T.M. Standards, Part II, p. 292, and 1928 Supplement to Book of A.S.T.M. Standards, p. 117, respectively.

(*b*) *Hanks or Bars.*—In sampling hanks or bars it is recommended that a whole hank or bar be selected. It shall be crushed and ground as rapidly as possible.

(*c*) *Ground Bleached.*—Ground bleached shellac may be sampled as described in Paragraph (*b*), bearing in mind that the large amount of moisture present makes rapid handling imperative.

Preparation of Sample.

4. The sample of shellac to be tested shall be thoroughly mixed and not less than a 100-g. portion shall be selected, ground to entirely pass a No. 20 (840-micron) sieve and kept in a tightly-stoppered container. The necessary determinations on the sample shall be made with as little delay as possible. As an added precaution all samples except those of dry bleached shellac shall be rolled 90 to 100 times before testing to insure uniformity of the sample. In the case of dry bleached shellac, the sample shall be thoroughly mixed by shaking the closed container so as to avoid possible loss of moisture.

MATTER INSOLUBLE IN HOT ALCOHOL

SOLUTION REQUIRED

Solution Required.

5. *95-per-cent Alcohol.*—Specially denatured alcohol, U. S. Internal Revenue Bureau Formula No. 1 or Formula No. 30.

PROCEDURE

A. Continuous Extraction Method (suitable for all grades of lac).

Apparatus.

6. (*a*) Any type of siphon extractor where the siphon is continuously surrounded by the vapors of boiling alcohol may be used. An apparatus which has been found satisfactory is shown in Fig. 1 and consists of a wide-neck flask in which is suspended a metal return condenser (see Paragraph (*b*)). From the lower part of this condenser is hung a siphon tube of the Knoefler type. The extraction cartridge used for the determination shall be cut down to such a size that the top of the cartridge is just above the upper curve of the siphon. It shall be supported on three indentations in the glass so that there will be a little space beneath and around the cartridge to permit of a free flow of liquid.

(*b*) An 8-in. glass condenser of the Allihn type (with bulbs) may be substituted for the metal condenser. The stem of the glass condenser shall be perforated with two holes, from which the siphon is suspended by wire. The condenser shall be fitted with a cork stopper to the neck of a flask of the same type and size as described in Paragraph (*a*).

Preparation of Extraction Cartridge.

7. (*a*) Prepare an extraction cartridge 26 mm. in diameter by 80 mm. in height (Schleicher and Schull No. 603 or the equivalent). Place the cartridge in the extraction apparatus and extract for 30 minutes with boiling 95-per-cent alcohol. Dry in an air bath at 105° C., transfer to a glass-stoppered weighing bottle, cool and weigh. Continue drying to constant weight. A number of cartridges may be prepared and kept in glass-stoppered weighing bottles until wanted.

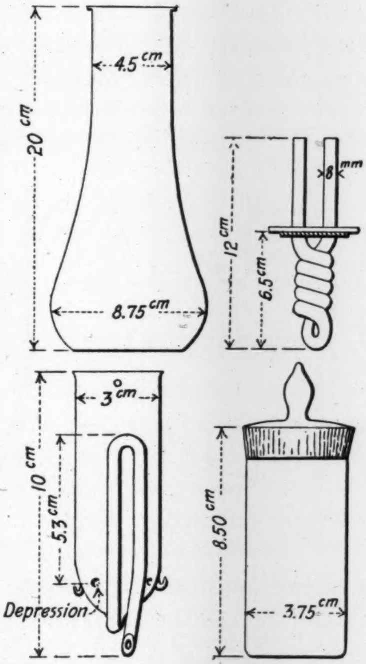

FIG 1.—Extraction Apparatus for Alcohol-Insoluble Matter in Shellac.

Procedure.

(*b*) Weigh 5 g. of the lac (Note 1) in a 200-cc. tall-form beaker and dissolve in 100 to 120 cc. of boiling 95-per-cent alcohol. Immerse the beaker in a hot-water bath, in order to be certain that all the shellac is dissolved and that the wax is in solution. Bring the alcohol and shellac mixture to a brisk boil and maintain at or near the boiling point for 30 minutes. Transfer this solution quickly into the weighed extraction cartridge previously wet with boiling-hot alcohol, putting the cartridge into a carbon filter tube of suitable size supported in a hot-water bath, Fig. 2, the outlet tube extending through the bottom of the bath allowing the escape of the filtrate. Wash all the residue from the beaker into the cartridge with boiling-hot alcohol. Put the cartridge in the extraction apparatus and extract to constant weight (in no case less than one hour). Keep the alcohol boiling briskly and maintain a free flow of cooling water through the condenser during the extraction. The rate of extraction may be controlled by the use of an electric stove, 6-in. in diameter, using a current of 2.2 amperes at 110 volts. Use a volume of 125 cc. of alcohol in the flask and protect the flask from draughts. Under these conditions the tube shall siphon over at least 33 times in one hour (Note 2). The condenser shall be able to return all the alcohol volatilized during the vigorous boiling of the contents of the flask, the object being to effect the maximum extraction in the minimum time.

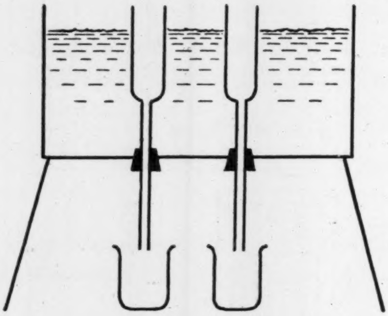

FIG. 2.—Filtering Device.

NOTE 1.—When the determination of the alcohol-insoluble matter in bleached shellac is required, the sample, if in the form of hanks or bars or ground bleached shellac, shall be dried, as the water present dilutes the alcohol to a point where solution may not be complete. It is recommended that in preparing shellac for this determination, a separate portion be dried by exposure to the air in a thin layer, without the application of heat.

NOTE 2.—Occasionally, shellacs, including dry bleached shellac, are met with that will not give the usual 33 siphons per hour. These shellacs should be reported as abnormal. This condition can usually be overcome by using a smaller quantity (2 g.) of shellac for the determination and proceeding as described in Section 7(*b*).

B. Gooch Filtration Method (not applicable to Stick, Seed, or Grain Lac and Bleached Shellac).

Procedure. 8. Weigh accurately 2 g. of the sample and transfer to a small beaker, and dissolve in 25 cc. of boiling 95-per-cent alcohol. Prepare a Gooch crucible with an asbestos pad in the usual manner[1] and dry it to constant weight. Arrange the crucible for filtration by suction and pour sufficient boiling-hot alcohol through it to thoroughly heat the crucible (Note 1). Immediately filter the boiling solution through the crucible, using suction. Transfer the insoluble material from the beaker to the crucible, using a "policeman" if necessary and a wash bottle containing boiling-hot alcohol until the washings are colorless and then wash five times more, nearly filling the crucible each time with boiling-hot alcohol (Note 2). Wash off any film of shellac on the sides or bottom of the crucible with boiling-hot alcohol and dry to constant weight in an oven at 105 to 110° C.

NOTE 1.—A cold crucible will congeal the wax and prevent filtration.

NOTE 2.—It will be necessary to shut off the suction momentarily to fill the crucible.

CALCULATION

Calculation.

9. The weight of the insoluble residue, multiplied by 100 and divided by the weight of the sample, is the percentage of material insoluble in hot alcohol.

IODINE NUMBER

SOLUTIONS REQUIRED

Solutions Required.

10. (*a*) *Acetic Acid.*—Glacial acetic acid (99-per-cent) having a melting point of 14.8° C. and free from reducing impurities. If these requirements are not complied with the results of the iodine number determination will be erratic. Determine the melting point and test the acid for reducing impurities as follows:

MELTING POINT DETERMINATION.—Fill a 6-in. test tube about two-thirds full of acid and insert into the acid an accurate thermometer (see Note) by means of a cork stopper fitting the test tube. The amount of acid should be at least double the quantity required to cover the bulb of the thermometer when the bottom of the latter is $\frac{1}{2}$ in. from the bottom of the test tube. Suspend this tube within a larger test tube by means of a cork. Cool the acid by immersing the assembly in ice water until the temperature is 10° C., then withdraw the assembly from the ice water and stir the acid rather vigorously for a few moments, thus causing the supercooled liquid to crystallize partially and give a mixture of liquid and solid acid. Take thermometer readings every 15 seconds and consider the true melting point that temperature at which the reading remains constant for at least two minutes.

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[1] For the preparation of the Gooch crucible see any standard text on quantitative analysis, for example, Fresenius (Cohn translation), p. 120, 1904, or Treadwell-Hall, sixth edition, Vol. II, p. 36.

NOTE.—An engraved stem thermometer calibrated between 10 and 65° C. in 0.1° C. intervals and with the 0° C. point marked on the stem, is recommended. The thermometer shall have an auxiliary reservoir at the upper end, a length of about 37 cm. and a diameter of about 6 mm. It is recommended that the thermometer be certified by the U. S. Bureau of Standards. A suitable thermometer is that used for the titer test, see "Methods of Analysis," Association of Official Agricultural Chemists, p. 280 (1925).

TEST FOR REDUCING IMPURITIES (Potassium Permanganate Test).[1]—Dilute 2 cc. of the acid with 10 cc. of distilled water and 0.1 cc. of 0.1 *N* $KMnO_4$ solution and maintain at a temperature of 24° C. ± 3° C. At the end of two hours the pink color shall not be discharged.

(*b*) *Wijs Iodine Monochloride Solution.*—Dissolve 13 g. of iodine in a liter of the acetic acid, using gentle heat if necessary, determining the strength by titration with thiosulfate. Set aside 50 to 100 cc. of the solution and introduce dry chlorine gas into the remainder until the characteristic color change occurs, and the halogen content has been nearly doubled as ascertained by titration. If the halogen content has been more than doubled, reduce it by adding the requisite quantity of the iodine acetic-acid solution. A slight excess of iodine does no harm but an excess of chlorine shall be avoided.

NOTE 1.—*Example.*—If the titration of 20 cc. of original iodine acetic-acid solution required 22 cc. of 0.1 *N* thiosulfate, 20 cc. of the finished Wijs solution should require between 43 and 44 cc. of the thiosulfate solution.

NOTE 2.—The Wijs solution should be tested against an orange shellac the iodine number of which is accurately known. The iodine number thus obtained should be within ± 0.5 of the known iodine number.

(*c*) *Chloroform.*—U. S. Pharmacopœia grade.

(*d*) *Standard Sodium Thiosulfate Solution.*—Dissolve pure sodium thiosulfate in distilled water that has been well boiled to free it from carbon dioxide in the proportion so that 24.83 g. crystallized sodium thiosulfate will be present in 1000 cc. of the solution. It is best to let this solution stand for about two weeks before standardizing. Standardize with pure resublimed iodine or potassium bi-iodate. (See Treadwell-Hall, *Analytical Chemistry*, Vol. II, 6th Edition, pp. 551 and 553.) This solution will be approximately 0.1 *N* and it is best to leave it as it is after determining its exact iodine value, rather than to attempt to adjust it to exactly 0.1 *N* strength. Preserve in a stock bottle with a guard tube filled with soda lime.

(*e*) *Starch Solution.*—Dissolve 0.2 g. of starch in 100 cc. of boiling water.

(*f*) *Potassium Iodide Solution.*—Prepare fresh by dissolving 10 g. of potassium iodide, free from iodate, in 90 cc. of distilled water.

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[1] *Industrial and Engineering Chemistry*, No. 18, p. 637, June 1926.

PROCEDURE

11. (*a*) Introduce a 0.2-g. sample (see Note 1) of finely-ground shellac into a 250-cc. dry, clear glass bottle having a ground-glass stopper. Add 20 cc. of glacial acetic acid and twirl the bottle gently on top of a hot-water bath at 65 to 70° C. until solution is complete, except for the wax. This should not require more than 15 minutes. A pure shellac is rather difficultly soluble; solution is quicker according to the percentage of rosin present. Add 10 cc. of chloroform and cool the solution to from 21.5 to 22.5° C. Allow the bottle to stand for at least 30 minutes half immersed in a shallow pan of water at a temperature of 21.5 to 22.5° C., well insulated or equipped with a suitable thermostat, before adding the Wijs solution. Add 20 cc. of the Wijs solution (Note 2), which shall be at a temperature of 21.5 to 22.5° C., from a pipette having a rather small delivery aperture (about 30 seconds). Close the bottle, place it again into the pan of water, and note the time. The bottle shall be kept half immersed in water at from 21.5 to 22.5° C. during the one hour that the shellac is exposed to the Wijs solution. Twirl the bottle occasionally during the hour. After exactly one hour, add 10 cc. of freshly-prepared potassium iodide solution, washing into the bottle any Wijs solution on the stopper with the same. Titrate the solution immediately with about 25 to 30 cc. of the 0.1 *N* sodium thiosulfate solution, allow the solution to run in rapidly and shake vigorously until the solution becomes a straw color. Now add 15 cc. of freshly prepared starch solution and slowly finish titrating. The end point is sharp; disregard any color returning after about 30 seconds. **Procedure.**

(*b*) *Blank.*—Run a blank determination on the reagents at the same time. The blank is necessary on account of the well-known effect of temperature changes on the volume, and possible loss of strength of the Wijs solution.

(*c*) *Standard Shellac.*—A determination on a sample of pure shellac of known iodine value shall also be run with every set of tests.

NOTE 1.—In the case of grossly adulterated samples, or in the testing of pure rosin, it is necessary to use, instead of 0.2 g. of material, a smaller quantity (0.15 or 0.1 g.) in order that the excess of iodine monochloride may not be too greatly reduced since the excess of halogen is one of the factors in determining the amount of absorption. In case less than 25 cc. of the thiosulfate solution is required, another test shall be made, using a smaller quantity of the shellac.

In weighing shellac, some difficulty is at times experienced on account of its electrical properties. In very dry weather it may be found that the necessary handling to prepare it for weighing has electrified it, and that it may be necessary to leave it in the balance pan at rest for a few minutes before determining the weight.

NOTE 2.—If a number of samples are being run, at least five minutes shall be allowed between the additions of the Wijs solution.

Calculation. 12. From the difference between the blank titration and the titration of the sample and the iodine value of the sodium thiosulfate solution, calculate the iodine number of the sample tested. (Iodine number is given in centigrams of iodine to 1 g. of sample.)

PURITY

Rosin. 13. *Qualitative Test for Rosin.*—Add 20 cc. of absolute alcohol or glacial acetic acid (melting point 13 to 15° C.) to 2 g. of the shellac and thoroughly dissolve. Add 100 cc. of petroleum ether and mix thoroughly. Add approximately 2 liters of water and separate a portion of the ether layer (at least 50 cc.) and filter if cloudy. Evaporate the petroleum ether and test the residue with the Halphen-Hicks[1] reagent as follows:

Solution A.—One part by volume of phenol dissolved in two parts by volume of carbon tetrachloride.

Solution B.—One part by volume of bromine dissolved in four parts by volume of carbon tetrachloride.

Add 1 to 2 cc. of Solution *A* to the residue left after evaporation of the petroleum ether solution and pour this mixture into a cavity of an ordinary porcelain color-reaction plate until it just fills the depression. Immediately fill an adjacent cavity with Solution *B*. Cover the plate with an inverted watch glass and note the color, if any, produced in the former solution by the action of the bromine vapors from Solution *B*. A decided purple or deep indigo blue color is an indication of the presence of rosin.

Copal. 14. *Qualitative Test for Copal.*—Make approximately a 35-per-cent solution of the shellac in 95-per-cent denatured alcohol, then filter. To 10 cc. of this filtrate in a large test tube (6 by $\frac{3}{4}$ in.), add 99-per-cent methyl alcohol to nearly fill the tube and thoroughly mix. The formation of a precipitate after standing is an indication of copal. Shellac free from copal should remain clear.

Estimation of Adulterant. 15. Since the variation between the highest and lowest iodine numbers of a pure shellac is not great it is recommended that the following assumptions be made:

Assumed iodine number of rosin-free and copal-free orange shellac.......... = 18
Assumed iodine number of rosin-free and copal-free bleached shellac........ = 10
Assumed iodine number of rosin.. = 228
Assumed iodine number of copal... = 130

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[1] *Industrial and Engineering Chemistry,* Vol. 3, p. 86 (1911).

The percentages of adulterants shall be determined from the following equations:

$$\text{Percentage of rosin in orange shellac} = \frac{x - 18}{228 - 18} \times 100$$

$$\text{Percentage of rosin in bleached shellac} = \frac{x - 10}{228 - 10} \times 100$$

$$\text{Percentage of copal in orange shellac} = \frac{x - 18}{130 - 18} \times 100$$

$$\text{Percentage of copal in bleached shellac} = \frac{x - 10}{130 - 10} \times 100$$

where

x = the iodine number of the sample under test, determined in accordance with Sections 11 and 12.

NOTE.—The results obtained by assuming the values of 18 and 10 as the iodine number of orange and bleached shellac, respectively, and 228 as the iodine number of rosin, may give a slightly lower percentage of rosin, under some circumstances, than that which is actually present.

MOISTURE

Procedure.

16. (*a*) *Orange Shellac and Dry-Bleached Shellac.*—Weigh a sample of 5 g. in a flat-bottomed dish about 4 in. in diameter and place the dish in a well-ventilated gas or electric oven for at least six hours at 41° C. ± 2° C., cool in a desiccator and weigh. Continue heating to constant weight.

NOTE.—Dry-bleached shellac is also termed "bone dry," "kiln-dry" or "vac-dry" bleached shellac.

(*b*) *Hanks and Ground-Bleached Shellac.*—Weigh a 5-g. sample in a flat-bottomed dish about 4 in. in diameter and dry in a desiccator over sulfuric acid for at least 12 hours. Place the dish in a well-ventilated gas or electric oven for at least six hours at 41° C. ± 2° C., cool in a desiccator and weigh. Continue heating to constant weight.

NOTE.—Average commercial orange shellac contains not more than 2 per cent of moisture.

Average commercial regular dry-bleached and dry-refined bleached shellac contain not more than 6 per cent of moisture.

Average commercial regular and refined bleached shellac in the form of hanks or bars, or ground bleached contain not more than 25 per cent of moisture.

WAX

SOLUTIONS REQUIRED

Solutions Required.

17. (*a*) *95-per-cent Alcohol.*—Specially denatured alcohol, U. S. Internal Revenue Bureau Formula No. 1 or Formula No. 30.

(*b*) *Chloroform or Carbon Tetrachloride.*—The solvents shall be redistilled before using as they must not leave a non-volatile residue.

(*c*) *Filter Cell.*—The filter cell shall be extracted before using with either of the solvents chloroform or carbon tetrachloride.

PROCEDURE

NOTE.—Average commercial orange and dry-bleached shellac will contain about 4 to 5.5 per cent of wax.

Average commercial dry-bleached refined shellac will be practically free from wax.

A. For Orange, Button, Seed, and Regular Bleached Shellac

Procedure. 18. Dissolve 10 g. of finely-ground dry shellac (Note 1) in 200 cc. of alcohol at a temperature of 24° C. ± 1° C. Allow the solution to stand for several hours (preferably over night) in a tall-form covered beaker, maintained at a temperature of 24° C. ± 1° C., until the wax has settled to a small layer at the bottom of the beaker. Decant the clear solution through a 12.5-cm. folded filter paper, taking care not to disturb the wax layer (Note 2). Finally, wash the wax onto the filter paper using approximately 25 cc. of alcohol at the prescribed temperature. Wash the beaker and the wax with three 25-cc. portions of the alcohol by directing a fine stream of alcohol from a wash bottle onto the edge of the filter paper, as the shellac has a tendency to dry on the edge. The final washings should be colorless, and the total filtrate should not exceed 300 cc. Allow most of the alcohol to evaporate from the filter paper at a temperature of 43° C.; when dry, wrap in a clean filter paper ($4\frac{1}{2}$ by $4\frac{1}{2}$ in.), and place in a Soxhlet siphon or any suitable continuous extraction apparatus (Note 3). Remove any wax from the beaker by boiling with approximately 50 cc. of chloroform, and filter this into the thimble. Extract for at least one hour, then distill off most of the chloroform and complete the evaporation on a water bath. Dry the wax residue at 105° C. to within 10 mg. of constant weight.

NOTE 1.—When the wax determination is made on bleached shellac in the form of hanks or bars or ground bleached shellac, the sample shall be dried as the water present dilutes the alcohol to a point where solution may not be complete. It is recommended that in preparing shellac for this determination, a separate portion be dried by exposure to the air in a thin layer, without the application of heat.

Shellac wax is not strictly insoluble in alcohol, the solubility increasing with a rise in temperature, but the above method gives results sufficiently accurate for commercial purposes providing the temperature is maintained within the prescribed limits.

NOTE 2.—During the filtration the funnel should be covered with a watch glass to prevent evaporation of alcohol and drying of shellac on the edge of the paper.

NOTE 3.—It is recommended that the wrapped wax residue be placed in a Schleicher and Schull or similar type extraction thimble or cartridge 25 by 70 mm. to prevent any insoluble matter being carried over.

B. For Machine-Made Shellac and Garnet Lac

Procedure. 19. Dissolve 10 g. of shellac and 2.5 g. of carbonate of soda in 150 cc. of hot water. Make the solution in a 200-cc. tall-form beaker; immerse the beaker in a steam or boiling-water bath and stir until the shellac is in solution. Then cover with a watch glass and allow to remain in the bath for 2 to 3 hours more without agitation. Remove the beaker from the bath and place it in cold water. The wax will come to the top, solidify as a layer or float as small hard particles according to the amount of wax present in the lac. Filter the solution through a 12-cm. folded filter paper, or a Büchner funnel (2¼ or 3½ in. in inside diameter) may be used. Cover the bottom of the Büchner funnel with a disk of filter paper, mix 1 g. of filter cell with water and pour onto the filter. Add 0.5 g. of filter cell to the solution, and filter with the aid of a vacuum. After washing-out the soluble shellac pour on a few cubic centimeters of alcohol to facilitate drying. When dry, remove the filter bed, wrap in filter paper, and extract in a suitable continuous extraction apparatus with chloroform or carbon tetrachloride for 1½ to 2 hours. Dry the wax at 105° C. to within 10 mg. of constant weight.

C. For Dry-Bleached Refined Shellac

Procedure. 20. In the case of dry-bleached refined shellac, dissolve 50 g. in 250 cc. of alcohol, add 1 g. of oxalic acid and stir until all is dissolved. Then add 0.5 g. of filter cell and allow to settle over night. Run the clear liquid through a Gooch crucible prepared with asbestos. Wash the sediment of wax and filter cell onto the crucible with alcohol. Dry at a low temperature, remove the asbestos mat, wrap in filter paper and extract in continuous extraction apparatus with chloroform or carbon tetrachloride for one hour. Dry the wax at 105° C. to constant weight.

MATTER SOLUBLE IN WATER

Procedure. 21. Weigh 10 to 25 g. of the finely-ground sample accurately and stir thoroughly with 200 cc. of distilled water in a suitable-size flask or beaker. Cover with a watch glass and allow to stand at room temperature (approximately 21° C.) for four hours, stirring occasionally. Decant the water through a 12.5-cm. filter paper into a weighed evaporating dish, washing the shellac and filter paper with at least

100 cc. of water. Evaporate the water and dry the extract at 105 to 110° C. for one hour or more to constant weight. Cool, weigh, and calculate the percentage of matter soluble in water.

ASH

Procedure. 22. Char a weighed quantity (3 to 5 g.) of the shellac and ignite at a low heat, not exceeding dull redness, until free from carbon. If a carbon-free ash can not be obtained in this manner, exhaust the charred mass with hot water, collect the insoluble residue on an ashless filter, burn the filter and contents until all the carbon is consumed. Add the filtrate, evaporate to dryness and heat to dull redness. Cool in a desiccator and weigh.

COLOR

Color. 23. Digest a weighed portion of the shellac with twice its weight of cold 95-per-cent alcohol, shaking at intervals until the shellac is entirely "cut" and proceed in accordance with Section 25 by the particular method agreed upon by the purchaser and seller.

METHODS OF TESTING SHELLAC VARNISH

Shellac varnishes are made by dissolving or cutting shellac in alcohol and are designated in the trade in terms of pounds of shellac to a gallon of alcohol, the 4, 4.5, and 5-lb. cut goods being most commonly used. Specially denatured alcohol (Formula No. 1) is largely used, and occasionally wood alcohol and butyl alcohol are used. Pure grain alcohol, or Formula No. 35 denatured, is used for confectioner's varnish or glaze.

GENERAL

Temperature. 24. (*a*) All tests, unless otherwise stated, shall be made at room temperature between 21 and 32° C. (70 and 90° F.).

Preparation. (*b*) The sample of shellac varnish shall be thoroughly agitated in the container immediately before portions are removed for the various tests and the unused portion shall be kept in a tightly-stoppered glass container, in a cool, dark place.

COLOR

Procedure. 25. The color of the sample shall be compared with the color of the shellac varnish mutually agreed upon by the purchaser and seller, by either of the following methods:

(*a*) *Comparison of Solutions.*—Shake both shellac varnishes well and then place equal portions of each in separate clear-glass tubes of the same diameter. Make the color comparison by placing the tubes together and comparing the colors.

(*b*) *Comparison of Films.*—Shake the shellac varnishes well and then allow them to stand for 30 minutes. Flow approximately equal portions of the two shellac varnishes on separate milk glass or porcelain plates and allow the films to dry in a vertical position. Make the color comparison upon the dried films.

NON-VOLATILE MATTER

Procedure. 26. A portion of the sample of the shellac varnish shall be poured into a stoppered bottle or weighing pipette and weighed. Not more than 1.5 g. of the sample shall be transferred to a weighed, flat-bottomed metal dish about 8 cm. in diameter (a friction-top can plug is satisfactory). The container shall be weighed again, and the exact weight of the portion of the sample transferred to the weighed dish shall be calculated by difference. For shellac varnishes over 5-lb. cut, add 10 g. of prepared sea sand (Note 1) and mix with the sample by means of a short glass rod. The dish with its contents shall be heated for 3 hours in an oven maintained at 105° C. ± 2° C. (221° F. ± 3.6° F.). It shall then be weighed after cooling.

NOTE 1.—The sand should have previously been prepared by digesting with hot HCl for about one hour, washing with water to remove all acid and soluble impurities, igniting, and then cooling in a desiccator.

Calculation. 27. The ratio of the weight of the residue to that of the sample, expressed as a percentage, shall be taken as the percentage of non-volatile matter in the varnish.

WAX

Procedure. 28. Weigh a quantity of the shellac varnish that will contain approximately 10 g. of non-volatile matter, dilute to about 200 cc. with 95-per-cent alcohol and proceed in accordance with Sections 17 to 20, inclusive.

MATTER INSOLUBLE IN HOT ALCOHOL

Procedure. 29. Matter insoluble in hot alcohol shall be determined by the continuous extraction method or by the Gooch filtration method as described in Sections 5 to 9, inclusive. In the case of the continuous extraction method, weigh a quantity of shellac varnish corresponding, as closely as practicable, to 5 g. of non-volatile matter, while with the Gooch filtration method take a weight of shellac varnish corresponding closely to 2 g. of non-volatile matter.

IODINE NUMBER

Procedure

30. Transfer about 1.5 cc. of the shellac varnish by means of a pipette to a flat-bottomed glass or porcelain dish at least 8 cm. in diameter. Add 1 to 2 cc. of 95-per-cent alcohol to spread the varnish evenly over the bottom of the dish. Heat the dish and contents at 75 to 80° C. for 30 minutes. Scrape the residue from the dish, accurately weigh 0.20 g. of the residue and transfer to a 250-cc. glass-stoppered bottle. In the case of badly adulterated samples, use a proportionately smaller weight of the residue. Proceed in accordance with the method for iodine number described in Sections 11 and 12.

PURITY

Qualitative Tests.

31. Qualitative tests shall be made for rosin upon the residue from shellac varnish evaporated at 75 to 80° C., and for copal upon the filtrate of shellac varnish filtered through dry filter paper in accordance with Sections 13 and 14.

Estimation of Adulterant.

32. If the qualitative test shows the presence of rosin but no copal or the presence of copal but no rosin, the percentage of rosin or copal, respectively, may be estimated from the iodine number as described in Section 15.

APPROXIMATE DRYING TIME

Procedure.

33. Pour the shellac varnish on a perfectly clean glass plate, at least 2 by 4 in. Place the plate in a nearly vertical position in a well-ventilated room but not in the direct rays of the sun. The temperature of the room should be between 70 and 90° F. (Note). Test the film at points not less than 2.5 cm. from the top and side edges of the film by touching lightly with the finger. The shellac varnish shall be considered to have "set to touch" when gentle pressure of the finger shows a tacky condition, but none of the varnish adheres to the finger. The shellac varnish shall be considered to have "dried hard" when the pressure that can be exerted on the film by the thumb and finger, when the film is placed between them, does not move the film or leave a mark which remains noticeable after the spot is lightly polished.

NOTE.—In cases of dispute, this test shall be made in a well-ventilated room maintained at a temperature of 70° F. and a relative humidity of 65 per cent saturation.

NATURE OF VOLATILE MATTER

Procedure.

34. Information concerning the volatile portion of a shellac varnish may be obtained by distilling approximately 50 cc. of shellac varnish to dryness, avoiding decomposition of the dry shellac by

excessive heat, and determining the boiling range of this distillate by a redistillation. A portion of the final distillate may be diluted with water to ascertain if other solvents, such as naphtha or benzol have been added. These will separate on dilution and the layer formed may be measured.

WEIGHT PER GALLON

Procedure.

35. Determine the specific gravity at 20° C. by any convenient method that is accurate to the third significant figure. A convenient method of determining specific gravity is to weigh a clean, dry 100-cc. volumetric flask calibrated at 20° C., fill to the mark with the shellac varnish at 20° C. and again weigh. The increase in weight divided by the capacity of the flask in grams of water is the specific gravity at 20° C. The specific gravity multiplied by 8.33 gives the weight in pounds per U. S. gallon.

NOTE.—The hydrometer does not give reliable or accurate indication of the specific gravity of shellac varnish.

CALCULATION OF BODY

Calculation of Body.

36. The calculation of body of shellac varnish in terms of pounds of shellac per gallon of alcohol shall be made upon the non-volatile matter. The weight of alcohol per 100 lb. of shellac varnish divided by 6.7793 (the weight of 1 gal. of 95-per-cent alcohol (Formula No. 1) at 15.5° C. (60° F.)), gives the number of gallons of alcohol present. From this the number of pounds of shellac per gallon of alcohol is determined.

NOTE.—*Example:*—Let 30.68 per cent of shellac be the result of a particular non-volatile determination:

Then 100 − 30.68 = 69.32 lb. of alcohol
69.32/6.7793 = 10.23 gal. of alcohol
30.68/10.23 = 3.0 lb. shellac per gal. of alcohol = body of shellac varnish

APPENDIX

Since shellacs contain various amounts of moisture the weight of shellac per gallon of alcohol to produce a specified body or cut will depend upon the percentage of moisture present in the shellac. For convenience, Table I has been compiled showing the pounds of moist shellac, for moisture contents from 1 to 6 per cent, per gallon of alcohol to produce shellac varnishes of 2.75 to 6.0-lb. cuts corresponding to percentages of non-volatile matter from 28.86 to 46.95, inclusive.

TABLE I.—POUNDS OF SHELLAC, CONTAINING VARIOUS PERCENTAGES OF MOISTURE, PER GALLON OF ALCOHOL, FOR SHELLAC VARNISHES OF VARYING PERCENTAGES OF NON-VOLATILE MATTER.

Body, lb. of Shellac per gal. of Alcohol	Non-Volatile Matter, per cent	Pounds of Moist Shellac per Gallon of Alcohol					
		Moisture, per cent					
		1	2	3	4	5	6
2.75	28.86	2.778	2.806	2.835	2.865	2.895	2.925
3.00	30.68	3.030	3.061	3.093	3.126	3.158	3.191
3.25	32.41	3.283	3.316	3.351	3.385	3.421	3.457
3.50	34.05	3.535	3.571	3.608	3.646	3.684	3.723
3.75	35.61	3.788	3.827	3.866	3.906	3.947	3.989
4.00	37.11	4.040	4.081	4.124	4.167	4.211	4.255
4.25	38.54	4.293	4.337	4.381	4.427	4.474	4.521
4.50	39.90	4.545	4.592	4.639	4.688	4.737	4.787
4.75	41.20	4.798	4.847	4.897	4.948	5.000	5.053
5.00	42.45	5.051	5.102	5.155	5.208	5.263	5.319
5.25	43.65	5.303	5.357	5.412	5.469	5.526	5.585
5.50	44.79	5.556	5.612	5.670	5.730	5.789	5.851
5.75	45.89	5.808	5.867	5.928	5.991	6.052	6.117
6.00	46.95	6.061	6.122	6.186	6.252	6.315	6.383

The following table shows the calculated weights per gallon of 3 to 6-lb. cut shellac varnishes with corresponding specific gravities and degrees Baumé, assuming the weight of water as 8.33 lb. per gal. The weight of 1 gal. of alcohol (No. 1 Special) at 15.5° C. (60° F.) is 6.7793 lb. according to Regulation No. 61, U. S. Internal Revenue:

BODY, LB. OF SHELLAC PER GAL. OF ALCOHOL	WEIGHT OF SHELLAC VARNISH PER GALLON, LB.	SPECIFIC GRAVITY, 15°/15° C. (60°/60° F.)	DEGREES BAUMÉ
3.0	7.522	0.9030	25.0
3.25	7.569	0.9086	24.1
3.50	7.614	0.9140	23.2
3.75	7.658	0.9193	22.3
4.0	7.699	0.9242	21.5
4.25	7.740	0.9292	20.7
4.50	7.779	0.9339	19.9
4.75	7.816	0.9383	19.2
5.0	7.853	0.9427	18.5
5.25	7.888	0.9469	17.9
5.50	7.922	0.9510	17.2
5.75	7.955	0.9550	16.6
6.0	7.987	0.9588	16.0

The following is an example of the method used to calculate the above theoretical weight of a gallon of shellac varnish:

6.7793 = weight of 1 gal., 95-per-cent alcohol, Formula No. 1 at 15° C. (60° F.).
5.0 = lb. of shellac per gallon of alcohol.
11.7793 = weight of shellac varnish (1.5 gal.).

$$\frac{11.7793}{1.5} = 7.853 \text{ weight of 1 gal. of 5-lb. cut shellac varnish.}$$

Shellac varnishes will not always agree exactly with the specific gravities given above. They will vary somewhat due to more or less moisture and insoluble matter contained in the white and orange shellac, also due to loss of solvent by evaporation. However, the above theoretical figures agree closely with accurately determined gravities on laboratory cuts and factory batches.

The weights of a gallon in above table are recommended as standard for trade use in determining the volume or gallons of shellac varnish.

Ten pound of shellac cut in 1 gal. of alcohol yields 2 gal. of varnish, hence 10 lb. of shellac cut in alcohol is equivalent to 1 gal.

Example.—

4 lb.	of shellac cut in 1 gal. alcohol yields	1.4	gal. varnish
4½ lb.	" " " " " " "	1.45	" "
5 lb.	" " " " " " "	1.50	" "

The following table shows corresponding percentages of gum shellac and alcohol in shellac varnishes of the 3.0 to 6.0-lb. cuts with No. 1 Specially Denatured Alcohol (95-per-cent, by volume) at 15.5° C. (60° F.).

BODY, LB. OF SHELLAC PER GAL. OF ALCOHOL	GUM SHELLAC, PER CENT	ALCOHOL, PER CENT
3.0	30.68	69.32
3.25	32.41	67.59
3.50	34.05	65.95
3.75	35.61	64.39
4.0	37.11	62.89
4.25	38.54	61.45
4.50	39.90	60.10
4.75	41.20	58.80
5.0	42.45	57.55
5.25	43.65	56.35
5.50	44.79	55.21
5.75	45.89	54.11
6.0	46.95	53.05

TENTATIVE METHODS OF SAMPLING AND TESTING LACQUER SOLVENTS AND DILUENTS[1]

A.S.T.M. Designation: D 268 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1927; REVISED, 1929.

Scope. 1. These methods cover the sampling and tests to be applied to solvents and diluents for use in the manufacture of nitro-cellulose lacquer.

SAMPLING

Sampling. 2. (*a*) The method of sampling specified in Paragraph (*b*) or (*c*) shall be used, according to the special conditions that obtain.

(*b*) *From Loaded Tank Car or Other Large Vessel.*—The composite sample taken shall not be less than ½ gal. and should consist of small samples of not more than 1 qt. each, taken from near the top and bottom by means of a metal or glass container with removable stopper or top. This device, attached to a suitable pole, shall be lowered to the desired depth, when the stopper or top shall be removed and the container allowed to fill.

(*c*) *Barrels and Drums.*—At least 5 per cent of the packages in any shipment shall be represented in the sample. The purchaser may increase the percentage of packages to be sampled at his discretion, and it is recommended that every package be sampled in the case of expensive solvents that are bought in small quantity. A portion shall be withdrawn from about the center of each package sampled by means of a "thief" or other sampling device. The composite sample thus obtained shall not be less than 1 qt. and shall consist of equal portions of not less than ½ pt. from each package sampled.

METHODS OF TESTING

Specific Gravity. 3. The specific gravity determination shall be made at 20° C. by any convenient method that is accurate to the third decimal point.

Color. 4. The sample and the standard mutually agreed upon by the buyer and seller shall be compared in 50-cc. Nessler tubes against a white background. For a solvent to be rated water-white, the visible color shall not be darker than a solution of 0.0030 g. of potassium bichromate in one liter of water.

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

Distillation. 5. The distillation test shall be conducted in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials,[1] except that all observations of volumes of distillate shall be read at the temperature specified for the individual solvent or diluent under test.

Residue. 6. Using a pipette, 5 cc. of the sample and of the standard shall be placed in separate porcelain evaporating dishes. These samples shall be allowed to evaporate in a hood for 24 hours. If any residue remains, its nature shall be noted and the test for non-volatile matter shall be made as described in Section 7.

Non-Volatile Matter. 7. Non-volatile matter of solvents and diluents shall be determined only when its presence is indicated by the results obtained in Section 6. One hundred cubic centimeters of the sample shall be placed in a weighed porcelain evaporating dish and evaporated almost to dryness on a steam bath. It shall then be heated in an oven at 100 to 110° C. to constant weight. The increase in the weight of the dish is the non-volatile matter of the sample, which should be expressed as a percentage, calculating the weight of the sample from its specific gravity, determined as described in Section 3.

Residual Odor. 8. Residual odor shall be determined for all solvents and diluents in which residual odor is an important property. Strips of heavy filter paper, of the same size and shape, shall be dipped to the same depth in beakers or wide-mouthed bottles containing the sample and the standard. They shall then be attached to a piece of wood with thumb tacks and at suitable intervals examined for difference in odor.

Water. 9. Five cubic centimeters of the sample shall be transferred to a 100-cc. glass-stoppered cylinder, and 60° Baumé gasoline added in 5-cc. portions, shaking well after each addition. Water is indicated by turbidity. If turbidity develops, the standard shall be tested in the same way and compared.

Acidity. 10. Using a pipette, 50 cc. of the sample shall be transferred to a small Erlenmeyer flask and titrated with 0.1 *N* KOH in 99-per-cent methyl alcohol, using phenolphthalein as an indicator. The weight of the sample shall be determined from the specific gravity and the acidity reported as miligrams of KOH per gram of sample.

Alkalinity. 11. Alkalinity of solvents and diluents shall be determined only when indicated by the results obtained in Section 10. Using a pipette, 50 cc. of the sample shall be transferred to a small Erlenmeyer flask and titrated with 0.1 *N* H_2SO_4, using methyl orange as an indicator. The weight of the sample shall be determined from its specific gravity and the alkalinity reported as milligrams of KOH per gram of sample.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378.

Ester Value. 12. One to two grams of the sample shall be weighed in an ampoule, by first weighing the empty ampoule, warming and filling, and then sealing-off and reweighing. The ampoule shall be placed in a 200-cc. Erlenmeyer flask which contains approximately one and one-half times the theoretical quantity of 0.5 *N* KOH required for complete saponification. The ampoule should be broken with a stirring rod and the flask connected with a reflux condenser. The flask shall then be heated on a steam bath for one to four hours, depending upon the ester being tested. During the heating the set-up and contents should be shaken frequently, taking the usual precautions to lose none of the contents. After the apparatus has cooled, the condenser shall be washed down with distilled water and three drops of phenolphthalein added to the contents of the flask as an indicator. The contents of the flask shall be titrated with 0.5 *N* HCl. Two blanks with alcoholic KOH shall be run along with the sample. These blanks should check to the first decimal point. The result shall be reported as percentage of ester by weight, allowing in the calculations for acidity or alkalinity as determined in Sections 10 and 11.

NOTE.—An optional method of weighing the sample is in a small weighing bottle, removing the stopper after introduction into the flask with a stirring rod, or by agitating the contents of the flask. Apparatus with glass joints should be used if available.

Copper Corrosion Test. 13. A copper corrosion test shall be run on solvents and diluents derived from coal tar and petroleum. A clean strip of mechanically polished pure sheet copper, about 1 in. square, shall be placed in a 4-in. porcelain evaporating dish and covered with 100 cc. of the sample. This shall be covered with a watch glass and heated on a steam bath for 30 minutes. The liquid shall be poured off and the copper examined for blackening. A slight tarnish shall be disregarded, but any marked blackening shall be cause for rejection.

TENTATIVE METHOD OF ROUTINE DETERMINATION OF ACETONE EXTRACT IN DRY LAMPBLACK AND DRY BONE BLACK[1]

A.S.T.M. Designation: D 305 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Procedure.

1. The acetone extract shall be determined as follows (Note 1): Weigh a sample of about 2 g., transfer to a 200-cc. volumetric flask, and add about 50 cc. of acetone (Note 2). Heat the solution to boiling (Note 3), cool, dilute to the mark with acetone, and mix thoroughly. Allow to settle, draw off about 120 cc. of the supernatant liquid, and filter it through a dry filter paper in a dry funnel, receiving the filtrate in a dry vessel. Discard the first 10 cc. of the filtrate, and transfer exactly 100 cc. of the clear subsequent filtrate to a dry, weighed dish. Evaporate this filtrate at a temperature not exceeding 75° C. After evaporation, heat the dish with residue for 30 minutes in an oven at a temperature of 100 to 105° C., cool and weigh. Run a blank determination with an equal volume of the acetone (Note 2), and correct the final weight accordingly. Calculate the percentage of acetone extract.

NOTE 1.—This is an arbitrary method and the details should be strictly followed. It is practically impossible to remove all matter soluble in acetone from lampblack. (See Goodwin and Park, *Industrial and Engineering Chemistry*, Vol. 20, No. 6, p. 621 (1928).)

NOTE 2.—The acetone should be redistilled before using.

NOTE 3.—The first boiling and the evaporation may be carried out with proper regulation on a steam bath, but an electric hot plate or heater is preferable.

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

TENTATIVE METHOD OF TEST
FOR
DETERMINATION OF POLISHING LUBRICANT IN ALUMINUM POWDER FOR PAINTS (ALUMINUM BRONZE POWDER)[1]

A.S.T.M. Designation: D 306 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

Issued, 1929.

Apparatus. 1. The apparatus shall consist of the following:

(*a*) *Extractor.*—An extractor of the form shown in Fig. 1 or any similar form in which the sample under test is surrounded by the boiling vapors of the solvent.

(*b*) *Alundum Thimble.*—An alundum thimble 30 mm. in width, 80 mm. in height, Grade *RA*, 98 coarse. If desired, two perforations may be made at opposite points near the top of the thimble and the latter suspended from hooks on the under surface of the metal cover of the extractor by nickel-silver or platinum wires, instead of being placed in the wire basket support, as shown in Fig. 1. A circle of filter paper, which may have some fine perforations, is folded in capsule form to fit in the top of the thimble, serving as a cap. Its purpose is to distribute the solvent and prevent splashing.

(*c*) *Evaporation Vessel.*—A small container to serve as an evaporation vessel. A 100-cc. extraction flask with a short, wide neck is suitable.

(*d*) *Balance.*—An analytical balance.

Procedure. 2. The determination shall be made as follows:

Place a sample of about 2 g. of the aluminum powder in the weighed alundum thimble, taking care to avoid spreading over the sides. Reweigh to find the exact amount of sample. Insert the cap or cover and place the thimble in position in the basket support (or suspended from the under side of the metal cover of the extraction apparatus). Hold the thimble, containing the sample, over the flask of the extraction apparatus containing 25 cc. of acetone (Note 1), pour another 25-cc. portion of acetone into the thimble to wet the sample. After the solvent has run through and drained, put the thimble in place and connect the extraction apparatus (Note 2). After the heating has become constant, adjust the source of heat so that the condensed liquid returns at a rate of about one drop per second. Continue the extraction for at least 16 hours.

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

At the end of the extraction, transfer the liquid from the flask of the extraction apparatus to the evaporation vessel, which has been dried, cooled, and weighed. Rinse the flask four times with a fine stream of acetone, adding the rinsings to the main portion. Evaporate the acetone from the extract at a gentle heat and finally dry in an oven for 30 minutes at a temperature of 100 to 105° C. (Note 3), cool and weigh. Run a blank determination with an equal volume of the acetone and correct the final weight accordingly. Calculate the percentage of polishing lubricant.

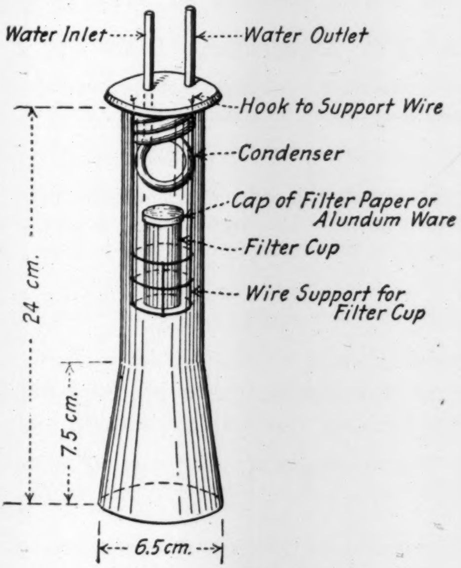

FIG. 1.—Extraction Flask.

NOTE 1.—The acetone should be redistilled before using.

NOTE 2.—The extraction and evaporation may be carried out on a steam bath, but an electric hot plate or heater at a temperature not exceeding 75° C. is preferable.

NOTE 3.—The extract should not be dried at a temperature above 105° C.

TENTATIVE METHOD OF ANALYSIS
FOR
THE COLOR CHARACTERISTICS OF PAINTS IN TERMS OF FUNDAMENTAL PHYSICAL UNITS[1]

A.S.T.M. Designation: D 307 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

This method determines the color characteristics of a paint in terms of fundamental physical units. The appearance of a painted surface may, however, be influenced by properties in addition to color, notably degree of gloss.

APPARATUS

Apparatus. 1. The apparatus shall consist of an instrument by means of which the spectral distribution curve of the reflection by a given sample, within the limits of the visible spectrum, may be determined.

NOTE.—Figure 1 shows one typical optical set-up of an instrument conforming to the above requirements. The explanation of this typical optical set-up is as follows:

S = Standard reflecting surface—a block of pure magnesium carbonate having a known reflection factor, usually 98 per cent or better;
S' = Sample;
H = Photometer;
HC = Photometer scale, calibrated in such a manner that the percentage of light reflected from the standard, when the standard is matched with the sample, at any wave length between 440 and 700 millimicrons, may be read directly;
CE = Collimator entrance slit;
L = Collimator objective;
P = Prism, mounted on a pivot, in such a manner that practically homogeneous light may be viewed through the eyepiece. The rotation of the prism is governed by a disk, calibrated in wave lengths from 440 to 700 millimicrons, in such a manner that the wave length of the homogeneous light, viewed through the eyepiece, E, may be read directly;

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

BP = Biprism, to bring light reflected from the surfaces of the standard and the sample into adjacent fields;
E = Eyepiece.

Standard Reflecting Surface.

2. The spectral reflection curve of the standard reflecting surface shall be known. The flat, even surface of a block of pure magnesium carbonate, if freshly and heavily fumed with magnesium oxide, makes a very suitable non-selective standard that is easily reproducible. The reflection factor of the standard reflecting surface shall be tentatively assumed as 98 per cent.

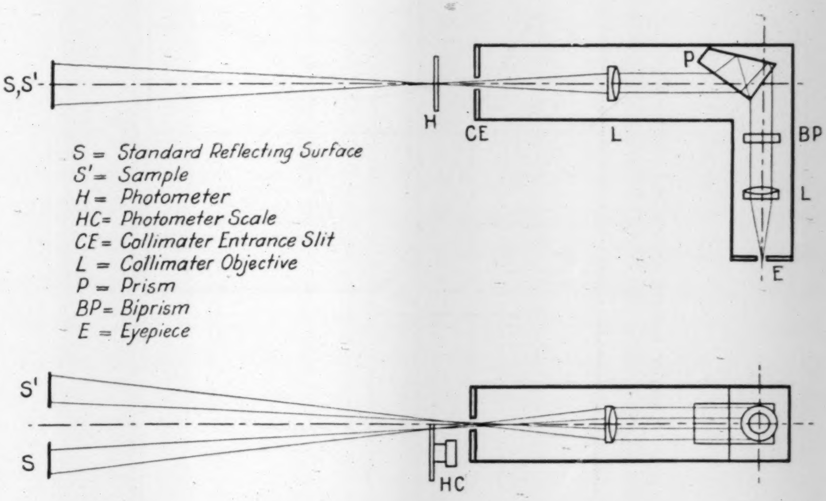
S,S'
H
CE
L
P
BP
L
E
S = Standard Reflecting Surface
S' = Sample
H = Photometer
HC = Photometer Scale
CE = Collimater Entrance Slit
L = Collimater Objective
P = Prism
BP = Biprism
E = Eyepiece
S'
S
HC

FIG. 1.—Typical Optical Set-Up for Color Determination.

Illumination.

3. The sample and standard shall be illuminated under identical conditions.

NOTE.—Diffuse illumination offers the most generally reproducible method of illuminating both sample and standard. It is recommended that for an intercomparison of results this type of illumination be used.

Calibrations.

4. (*a*) The calibration of the photometer scale or other intensity measurement unit shall be carefully checked for accuracy, at reasonable intervals, by comparison with an absolute standard.

(*b*) The accuracy of the wave length calibrations shall be checked, at reasonable intervals, by a sodium flame or other acceptable means.

PROCEDURE

Procedure. 5. (*a*) The sample to be analyzed shall be handled carefully to avoid discoloration. The condition of the sample before and after analysis shall be carefully noted and any change in the appearance of the surface shall be recorded.

(*b*) Readings shall be made at each of various wave lengths of the visible spectrum sufficient in number to establish a reliable indication of the percentage of light reflected by the sample at each of these wave lengths, the number of wave lengths at which the determinations are made to be sufficient to accurately represent, graphically or numerically, the characteristic spectral reflection of the sample.

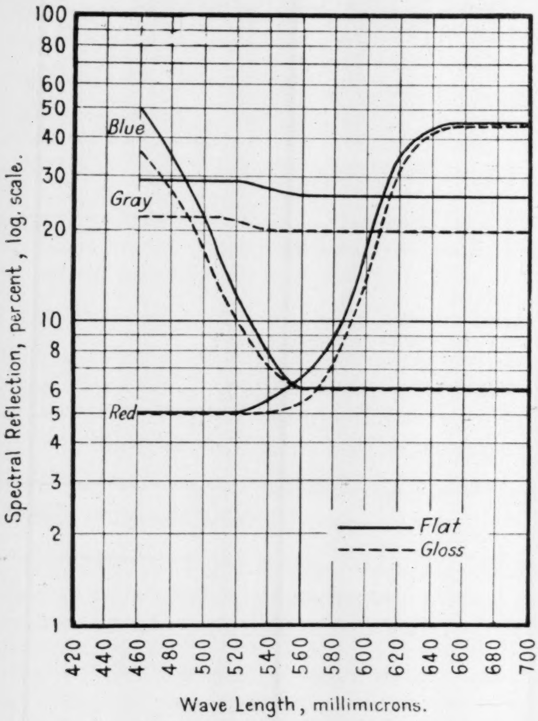

FIG. 2.—Typical Spectral Reflection Curves.

NOTE.—Typical spectral reflection curves of a red, blue and gray paint are shown in Fig. 2.

Record. 6. The results obtained shall be preserved as a record.

Rejection. 7. If the sample visibly undergoes a change during the analysis, the readings shall be rejected. (See Note, Section 3.)

REPORT

8. The report of the color characteristics of a paint shall consist of the following: **Report.**

(*a*) The characteristic spectral reflection in terms of fundamental physical units determined in accordance with Section 5 (*b*);

(*b*) The nature of and the reflection factor of the standard reflecting surface employed, as specified in Section 2.

(*c*) The character of the illumination as specified in Section 3 (*a*).

TENTATIVE METHOD OF TEST
FOR
EXPRESSIBLE OIL AND MOISTURE IN PARAFFIN WAXES[1]

A.S.T.M. Designation: D 308 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. This method is the well-known press method for the determination of oil and moisture in paraffin wax. It is applicable to crude, semi-refined and refined paraffin waxes melting at or above 108° F. (42.2° C.).

NOTE.—It has been established that the expressible oil and moisture content does not bear a direct relation to the actual oil content of a given sample of paraffin wax. However, it is extremely difficult to determine actual oil content by any known method. The expressible oil and moisture method has been in almost universal use for many years and no doubt comes nearer to giving the information desired than any other method so far devised.

APPARATUS

Press. 2. The press shall be of any suitable form and shall be capable of producing and maintaining a pressure of 1000 lb. per sq. in. ± 100 lb. per sq. in. over the working surface of the platens, the latter having a diameter of 3.50 in. This will require a total pressure of 9620 lb. ± 962 lb. upon the platen assembly. When presses of either the lever type or hydraulic type are used, it may be necessary to readjust the weights in the case of the former, or the gage pressure in the case of the latter, to secure the specified pressure.

Press Platens. 3. (*a*) The press platens shall be constructed of steel, properly plated, or of a suitable rust-resisting metal. The working surfaces of the platens shall be so finished as to be completely free from tool marks. The press platens shall conform to the dimensions shown in Fig. 1.

(*b*) When assembled for use, the platens shall be connected in series by means of rubber tubes of such length that the platens may be manipulated without interrupting the flow of water through the assembly. The use of the complete platen assembly makes possible the simultaneous pressing of three samples of paraffin wax.

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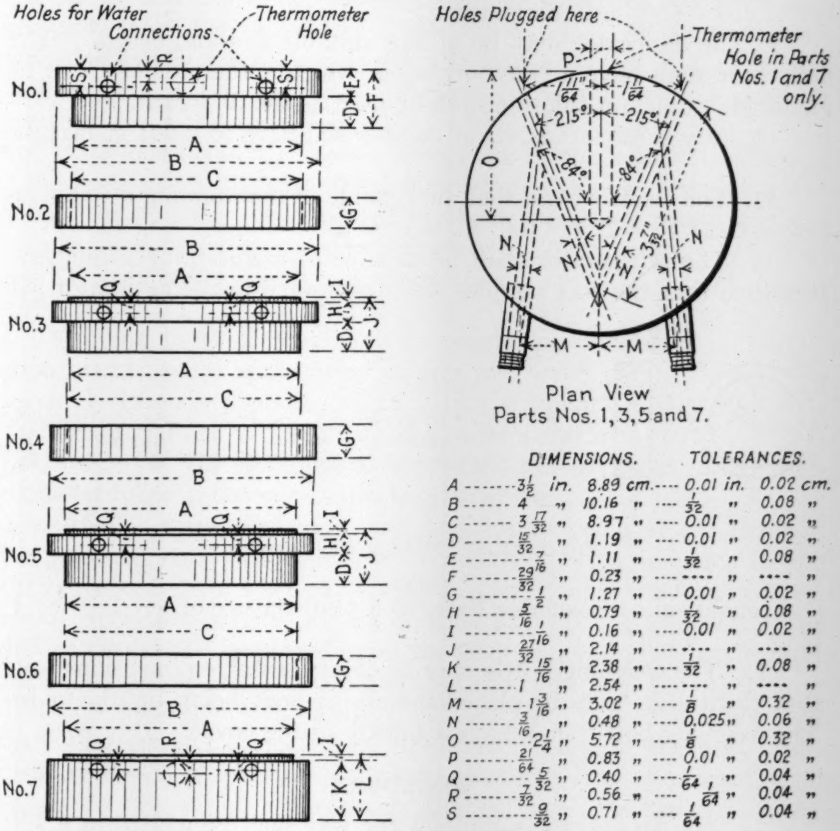
[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. R. P. Anderson, Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

Wax Sample Molds.

4. The molds for wax samples shall consist of three smoothly-turned brass rings conforming to the dimensions shown in Fig. 2.


Holes for Water Connections
Thermometer Hole
No.1
No.2
No.3
No.4
No.5
No.6
No.7
A
B
C
D
E
F
G
H
I
J
K
L
Q
R
S
Holes Plugged here
Thermometer Hole in Parts Nos. 1 and 7 only.
P
$1\frac{11}{64}''$
$1\frac{11}{64}''$
21.5°
21.5°
84°
84°
O
N
N
N
N
$3\frac{3}{32}''$
M
M
Plan View
Parts Nos. 1, 3, 5 and 7.

	DIMENSIONS.		TOLERANCES.	
A	$3\frac{1}{2}$ in.	8.89 cm.	0.01 in.	0.02 cm.
B	4 "	10.16 "	$\frac{1}{32}$ "	0.08 "
C	$3\frac{17}{32}$ "	8.97 "	0.01 "	0.02 "
D	$\frac{15}{32}$ "	1.19 "	0.01 "	0.02 "
E	$\frac{7}{16}$ "	1.11 "	$\frac{1}{32}$ "	0.08 "
F	$\frac{29}{32}$ "	0.23 "	.... "	.... "
G	$\frac{1}{2}$ "	1.27 "	0.01 "	0.02 "
H	$\frac{5}{16}$ "	0.79 "	$\frac{1}{32}$ "	0.08 "
I	$\frac{1}{16}$ "	0.16 "	0.01 "	0.02 "
J	$\frac{27}{32}$ "	2.14 "	.... "	.... "
K	$\frac{15}{16}$ "	2.38 "	$\frac{1}{32}$ "	0.08 "
L	1 "	2.54 "	.... "	.... "
M	$1\frac{3}{16}$ "	3.02 "	$\frac{1}{8}$ "	0.32 "
N	$\frac{3}{16}$ "	0.48 "	0.025 "	0.06 "
O	$2\frac{1}{4}$ "	5.72 "	$\frac{1}{8}$ "	0.32 "
P	$\frac{21}{64}$ "	0.83 "	0.01 "	0.02 "
Q	$\frac{5}{32}$ "	0.40 "	$\frac{1}{64}$ "	0.04 "
R	$\frac{7}{32}$ "	0.56 "	$\frac{1}{64}$ "	0.04 "
S	$\frac{9}{32}$ "	0.71 "	$\frac{1}{64}$ "	0.04 "

FIG. 1.—Press-Platen Assembly.

When in use the rings shall be supported by a smooth No. 16 B. & S. gage brass plate, 3 in. ± ⅛ in. (7.62 cm. ± 0.3 cm.) square.

Thermometer.

5. The A.S.T.M. Cloud and Pour Thermometer, conforming to the requirements specified in Section 4 (*a*) of the Standard Method of Test for Cloud and Pour Points of Petroleum Products (A.S.T.M. Designation: D 97) of the American Society for Testing Materials[1] shall be used.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 133.

Graduated Cylinder. 6. An ordinary 25-cc. graduated cylinder may be used.

Cloth. 7. The cloth shall be a white or colored "silesia" or "duretta" or similar tightly-woven cloth free from nap. The cloth shall be accurately cut in disks 3.50 in. in diameter.

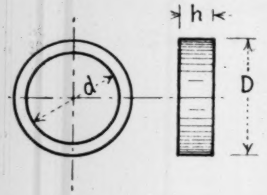
Filter Paper. 8. The filter paper used shall be Whatman's No. 1 filter paper, cut in disks 3.50 in. in diameter.

Desiccator. 9. The desiccator may be of any suitable size and design. The desiccator shall have a side opening in which a thermometer can be mounted. Calcium chloride shall be used as the desiccant.

Balance. 10. Any suitable analytical balance sensitive to 0.001 g. may be used.

Electric Oven. 11. The electric oven shall be capable of maintaining a temperature of 212° F. ±2° F. (100° C. ±1° C.).

Refrigerator. 12. The refrigerator shall be capable of maintaining a temperature such that the wax samples when contained in the desiccator will be brought, in a reasonable time, to a temperature of 60° F. ±5° F. (15.6° C. ±3° C.).



	DIMENSIONS.		TOLERANCES.	
D	$1\frac{5}{16}$ in	3.30 cm.	$\frac{1}{32}$ in.	0.08 cm.
d	$1\frac{1}{16}$ "	2.70 "	$\frac{1}{64}$ "	0.04 ".
h	$\frac{23}{64}$ "	0.91 "	$\frac{1}{64}$ "	0.04 ".

FIG. 2.—Ring Mold for Wax Samples.

Weighing Bottle. 13. The weighing bottle may be of any suitable dimensions[1] such that cloth disks may be placed therein without being tightly folded. The weighing bottle shall have a tightly fitting cover.

PROCEDURE

Procedure. 14. (*a*) An average sample of the wax shall be melted in a suitable container using a water bath whose temperature shall not be more than 35° F. (19.5° C.) above the approximate melting point of the wax sample. Direct heat, such as a flame or hot plate, shall not be used and the wax sample shall not be held in the melted condition any longer than necessary. The sample mold ring shall be placed upon the brass plate, the latter being accurately supported in a horizontal position. After thorough mixing, a portion of the wax sample shall be poured into the 25-cc. graduated cylinder which has previously been heated by immersion in the water bath, and 2.5 to 3.0 cc. of the melted wax poured from the graduate into the sample mold ring. The wax sample shall be allowed to solidify at room temperature.

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[1] The American Can Co.'s Gill style ointment box, deep pattern, 3-oz. capacity may be used, provided they are selected with closely fitting lids.

(*b*) Two cloth disks shall be placed in the weighing bottle and the bottle with its cover removed shall be dried for one hour at a temperature of 212° F. ±2° F. (100° C. ±1° C.). The cover of the weighing bottle shall be replaced, the bottle cooled in a desiccator and weighed to the nearest milligram. The wax sample shall be removed from the mold and placed within the weighing bottle with the cloth disks and the bottle reweighed to the nearest milligram. After reweighing, the closed weighing bottle shall be returned to the desiccator and the latter placed in the refrigerator, where the wax sample shall be cooled to a temperature of 60° F. ±5° F. (15.6° C. ±3° C.), as indicated by a thermometer mounted in the side of the desiccator.

(*c*) The press platens shall be assembled as shown in Fig. 1, connected together with rubber tubing, and water passed through the assembly in such a manner that both the upper and lower platens shall be brought to and maintained at a temperature of 60° F. ±5° F. (15.6° C. ±3° C.) as indicated by thermometers placed in the thermometer holes in the upper and lower platens.

(*d*) The wax sample and the dry platens being at the required temperature, and the lower platen and ring being in place in the press, three disks of filter paper shall be placed upon the lower platen, making certain that the papers lie smoothly upon the platen. One disk of cloth shall be placed upon the filter papers. The wax sample shall then be placed upon the center of the cloth, and the other cloth disk laid upon the wax sample. Three filter papers shall be laid upon the second cloth disk and the upper platen, or the next intermediate platen, if more than one sample of wax is to be pressed, shall be placed in position. Under no circumstances, shall a pressing be made with other than the lower platen at the bottom of the assembly and the upper platen at the top of the assembly. A pressure of 1000 lb. per sq. in. ±100 lb. per sq. in. of the working surface of the platens, equivalent to a total pressure of 9620 lb. ±962 lb., shall be applied and maintained for a period of five minutes, after which time the pressure shall be released and the upper platen and ring removed. The two filter papers immediately adjacent to the sandwich of wax and cloth and any others which show traces of oil, when observed by transmitted light, shall be removed and replaced by fresh papers, and the pressing operation repeated. The filter paper shall be changed a second time and a third pressing made. During humid weather, platens may sweat considerably. In this case, care shall be exercised to prevent moisture from getting on the cloth-wax sandwich while changing the filter papers. Immediately before assembling the platens, they shall be wiped as dry as possible.

(*e*) After the three pressings have been made, the cloth-wax sandwich shall be folded and returned to the weighing bottle, care being taken to avoid loss of wax by crumbling. The weighing bottle with its cover removed shall be placed in the electric oven and dried for one hour at a temperature of 212° F. ± 2° F. (100° C. ± 1° C.). The cover of the weighing bottle shall be replaced, the bottle cooled in a desiccator and weighed to the nearest milligram.

Calculation.

15. The percentage of expressible oil and moisture shall be calculated as follows:

$$\begin{array}{l}\text{Percentage of}\\ \text{Expressible Oil}\\ \text{and Moisture}\end{array} = \left(\frac{\begin{array}{c}\text{weight lost by cloth-wax}\\ \text{sandwich during pressing}\end{array}}{\text{weight of wax sample}} \times 100 \right) - 0.3$$

NOTE.—The correction of 0.3 is applied in order to correct for the loss of paraffin wax expressed along with the oil and moisture.

Duplicate Determinations.

16. With care and proper attention to detail, the amount of expressible oil and moisture determined in duplicate tests should not differ by more than 0.5 per cent.

Negative Result.

17. Should a wax show negative content of expressible oil and moisture, the wax shall be reported as containing no expressible oil and moisture.

TENTATIVE METHOD OF TEST
FOR
DISTILLATION OF CRUDE PETROLEUM[1]

A.S.T.M. Designation: D 285 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1928; REVISED, 1929.

Scope.

1. This method is intended for determining the percentages and distillation range of the naphtha in any crude oil of the class commercially known as refinable crudes. This method does not attempt to specify what quality of product shall be defined as naphtha nor can it be expected to duplicate the results of commercial refining operations. It defines apparatus and procedure, leaving selection of numerical limits and interpretation of results to be agreed upon by the interested parties.

APPARATUS

Flask.

2. *Flask.*—The distillation flask shall be a 300-cc. Hempel distilling flask, Fig. 1, the dimensions and allowable tolerances being as follows:

			Tolerances	
	Centimeters	Inches	Centimeters	Inches
Diameter of bulb, outside...	10.2	4.0	±0.2	±0.08
Diameter of neck, outside...	2.9	1.125	±0.1	±0.04
Length of neck............	25.4	10.0	±0.4	±0.16
Distance, top of neck to center of vapor tube......	6.4	2.5	±0.3	±0.12
Length of vapor tube......	17.2	6.75	±0.5	±0.20
Diameter of vapor tube, outside..................	0.8	0.3125	±0.1	±0.04

The vapor tube shall be set at an angle of 75 deg. with the neck of the flask, subject to a permissible variation of plus or minus 5 deg.

Fractionating Column.

3. *Fractionating Column.*—The fractionating column (see *a*, Fig. 2) shall be made of a length of No. 18 iron jack chain, enough to pack under its own weight into a column 2.54 cm. (1 in.) in diameter and 17.51 cm. (6½ in.) in length. It may conveniently be "strung" on a

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. R. P. Anderson. Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

loop of wire so that it hangs in loops about 2 ft. in length, which makes the chain more convenient to handle than when it is not looped together. The device used for supporting the column (see *b*, Fig. 2) shall be made of a suitable length of wire, preferably, though not necessarily of nickel-chromium, about No. 18 gage. One end shall be wound in a spiral a little less than 1 in. in diameter, and the remaining wire shall be bent at right angles to the plane of the spiral and cut off at a length of about 9½ in. A small loop shall be bent into the end away from the spiral and put through a hole drilled in a strip of spring steel (see *c*, Fig. 2) or other suitable material about 0.015 in. in thick-

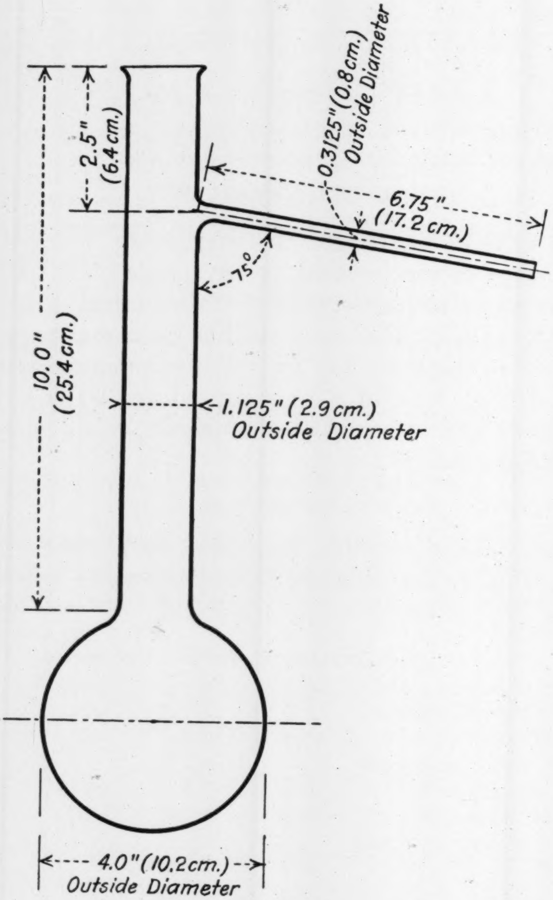
2.5"
(6.4 cm.)
10.0"
(25.4 cm.)
0.3125" (0.8 cm.)
Outside Diameter
6.75"
(17.2 cm.)
75°
1.125" (2.9 cm.)
Outside Diameter
4.0" (10.2 cm.)
Outside Diameter

FIG. 1.—Dimensions of a 300-cc. Hempel Flask.

ness, $\frac{3}{8}$ in. in width, and 3 in. in length, bent around a cylinder 1 in. in diameter. When allowed to expand this spring strip should hold firmly on the inside of the neck of the flask and provide a secure support for the column of chain.

Thermometer.

4. *Thermometer.*—The A.S.T.M. Low-Distillation Thermometer, conforming to the requirements specified in Section 6 of the Standard Method of Test for Distillation of Natural Gas Gasoline (A.S.T.M. Designation: D 216) of the American Society for Testing Materials[1] shall be used.

Condenser.

5. *Condenser.*—The condenser shall consist of a $\frac{9}{16}$-in. (14.29-mm.) OD No. 20 Stubbs Gage seamless brass tube, 22 in. (55.88 cm.) in length. It shall be set at an angle of 75 deg. from the perpendicular and surrounded with a cooling bath 15 in. (38.1 cm.) in length, approximately 4 in. (10.16 cm.) in width, by 6 in. (15.24 cm.) in height. The lower end of the condenser tube shall be cut off at an acute angle, and curved downward for a length of 3 in. (7.62 cm.) and slightly backward to insure contact with the wall of the graduate 1 to $1\frac{1}{4}$ in. (2.54 to 3.18 cm.) below the top of the graduate when it is in position to receive the distillate.

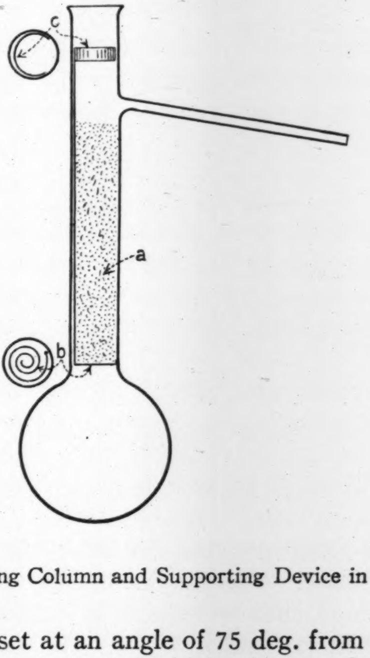

FIG. 2.—Fractionating Column and Supporting Device in a Hempel Flask.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 387.

Shield and Support.

6. *Shield and Support.*[1]—The shield shall be of any convenient type having a minimum horizontal dimension of 6 in. The flask shall rest on a board of ¼-in. (0.64-cm.) transite or hard asbestos, in the center of which is cut a hole 3½ in. (8.9 cm.) in diameter. The board shall not be less than 6 in. (15.24 cm.) in width and shall be supported by an ordinary ring stand and ring.

7. *Gas Burner or Electric Heater:*

Gas Burner.

(*a*) *Gas Burner.*—The burner shall be so constructed that sufficient heat can be obtained to distill the product at the uniform rate specified below. The flame should never be so large that it spreads over a circle of a diameter greater than 5 in. (12.7 cm.) on the under surface of the asbestos board. A sensitive regulating valve is a necessary adjunct, as it gives complete control of heating.

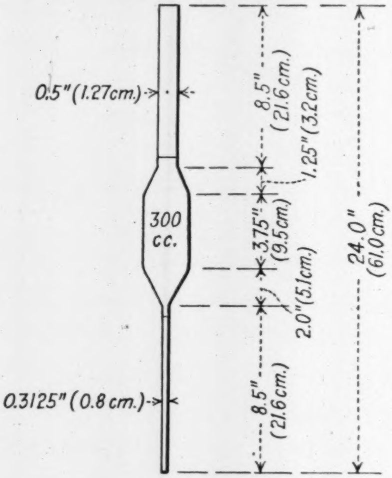

FIG. 3.—Measuring Pipette.

Electric Heater.

(*b*) *Electric Heater.*—The electric heater, which may be used in place of the gas flame, shall be capable of maintaining the distillation at the rate specified in Section 9 (*i*). The electric heater shall be fitted with an asbestos board top ⅛ to ¼ in. (3.18 to 6.35 mm.) in thickness having a hole 3½ in. (8.9 cm.) in diameter in the center. When an electric heater is employed the portion of the shield above the asbestos board shall be the same as with the gas burner, but the part below the board may be omitted.

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[1] An illustration of the condenser and of a suitable shield and support are shown in Fig. 2 of the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products (A.S.T.M Designation: D 86) of the American Society for Testing Materials, 1927 Book of A.S.T.M. Standards, Part II, p. 378.

8. *Measuring Graduates and Pipettes.*—Filling charges and distillation fractions shall be measured with suitable accurate graduated cylinders or other volumetric glassware. A special 300-cc. pipette, Fig. 3, is a convenient device for measuring charges, but an accurate graduate may be used if desired. The regular 100-cc. graduate used in gasoline distillations as specified in Section 7 of the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials[1] is reasonably satisfactory for measuring distillation fractions, but a graduate of similar dimensions that can be tightly stoppered is preferable. One can be made by cutting down a standard graduate to remove the lip and then fire polishing. **Graduates and Pipettes.**

PROCEDURE

9. (*a*) The condenser bath shall be filled with cracked ice and sodium chloride or calcium chloride to form a freezing mixture that will cover the condenser tube and maintain a temperature between 0 and 10° F. **Procedure.**

(*b*) The condenser tube shall be swabbed or cleaned inside to remove any liquid remaining from a previous test.

(*c*) The specific gravity of the oil to be tested shall first be determined in accordance with the Tentative Method of Test for Gravity of Petroleum and Petroleum Products by Means of the Hydrometer (A.S.T.M. Designation: D 287 - 28 T) of the American Society for Testing Materials.[2]

(*d*) A 300-cc. sample of the oil[3] shall be measured into the Hempel flask by any suitable means. For less viscous oils a pipette or graduate may be used. If the oil is decidedly viscous a sample equivalent to 300-cc. at 60° F. shall be weighed into the flask. None of the liquid shall be permitted to flow into the vapor tube.

The weight in grams of the 300-cc. sample shall then be calculated. (The weight in grams of 300 cc. of oil is equivalent to 300 times its specific gravity determined in accordance with Paragraph (*c*).)

(*e*) The supporting device for the fractionating column, Fig. 2, shall be put in place and the proper quantity of iron chain dropped in carefully so that it fills the space uniformly and without channels. Tapping the flask while the iron chain is being added is helpful, but the column shall not be compressed after all the chain is in place.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 924 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 388.

[3] **In case water in the crude oil causes bumping, the sample shall be dehydrated by some suitable method, without loss of naphtha, before making the determination.**

(*f*) The thermometer, provided with a cork, shall be fitted tightly into the flask, so that it will be in the middle of the neck and so that the lower end of the capillary tube is about $\frac{1}{16}$ in. below the level of the inside of the bottom of the vapor tube at its junction with the neck of the flask.

(*g*) The charged flask shall be placed in position on the hard asbestos board, used with the gas burner or the electric heater and connected to the condenser with a carefully fitted cork through which the vapor tube passes. The position of the flask shall be adjusted so that the vapor tube extends into the condenser tube not less than 1 in. (2.54 cm.) nor more than 2 in. (5.08 cm.)

(*h*) A clean, dry, graduated cylinder shall be placed at the outlet of the condenser tube in such a position that the condenser tube shall extend at least 1 in. into the graduate. The graduate shall be immersed up to the level of about 1 in. below the top of the condenser tube in a transparent container of water maintained at a temperature of from 32 to 40° F. (0 to 4.4° C.). During the distillation, the top of the graduate shall be covered closely with a piece of blotting paper or its equivalent, cut to fit the condenser tube tightly.

(*i*) When everything is in readiness, heat shall be applied. The fractionating column causes some little delay between the time when the liquid starts to boil and the time the vapor enters the condenser. It is, therefore, permissible to apply heat vigorously until the liquid begins to boil, then to slow down the application of heat so that the distillate begins to come over at a moderate rate. For the first 5 to 10 cc. distilled the rate shall be from 2 to 3 cc. per minute; thereafter, the rate of distillation shall be increased to from 4 to 5 cc. per minute.

Distillation.

(*j*) When the thermometer reads ....[1] the graduate shall be withdrawn from beneath the condenser and the distillation discontinued. The graduate shall be tightly stoppered and allowed to stand until all sediment and moisture have settled out and until its contents have reached a temperature between 55 and 65° F. The total volume in the graduate shall then be read and recorded as D. The volume of water, if any, shall be read and recorded as W.

The percentage of naphtha in the crude oil shall be calculated from the following formula:

$$\text{Percentage of naphtha} = \frac{D - W}{300 - W} \times 100$$

The whole procedure shall be repeated enough times to yield a total volume of distillate of not less than 100 cc.

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[1] The temperature at which the distillation shall be stopped can best be decided by mutual agreement between the parties concerned in the evaluation of a given crude petroleum.

Naphtha Distillation.

10. *Naphtha Distillation.*—The distillates shall be poured together (taking care to avoid losses by evaporation and rejecting the layers of water, if present) and shall be mixed thoroughly by shaking. A distillation test of the combined distillates shall be made in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials,[1] except that the initial boiling point shall be recorded and the volume of distillate collected in the cylinder shall be observed and recorded to the nearest 0.5 cc. when the mercury of the thermometer reaches 212° F. (100° C.), 221° F. (105° C.), 284° F. (140° C.), 392° F. (200° C.) and the end point.

ACCURACY

Accuracy.

11. Results of duplicate tests in the crude-oil distillation should not differ from each other by more than 0.5 per cent. In the naphtha distillation duplicate results obtained for initial boiling point and maximum temperature, respectively, shall not differ from each other by more than 6° F. (3.33° C.). Duplicate readings of the volume of distillate collected in the cylinder when each of the prescribed temperature points is reached should not differ by more than 2 cc.

CORRECTION FOR BAROMETRIC PRESSURE

Correction.

12. The actual barometric pressure shall be ascertained and recorded, but no correction shall be made except in case of dispute, when the temperature points shall be corrected to 760 mm. (29.92 in.) by the use of the Sydney Young Equation, as follows:

For Centigrade Readings:

$$C_c = 0.00012\ (760 - P)(273 + t_c)$$

For Fahrenheit Readings:

$$C = 0.00012\ (760 - P)(460 + t_f),$$

in which C_c and C_f are, respectively, corrections to be added to the observed temperature t_c or t_f; and P is the barometric pressure in millimeters of mercury.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378.

TENTATIVE METHOD OF TEST
FOR
PRECIPITATION NUMBER OF LUBRICATING OILS[1]

A.S.T.M. Designation: D 91 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1921; REVISED, 1929

Scope.

1. This method is commonly used for steam cylinder stocks and black oils and may be used for other lubricating oils.

DEFINITION

Definition.

2. *A.S.T.M. Precipitation Number of Lubricating Oils.*—The number of cubic centimeters of precipitate formed when 10 cc. of lubricating oil are mixed with 90 cc. of petroleum naphtha as specified in Section 5 and centrifuged under prescribed conditions.

APPARATUS

Centrifuge.

3. *Centrifuge.*—The centrifuge shall be capable of whirling at least two 100-cc. centrifuge tubes filled with water at the required speed. It shall be of sound design and rugged construction so that it may be operated without danger. The tube carriers shall be so designed that the glass centrifuge tubes may be cushioned with water, rubber or other suitable material. The tube holders shall be surrounded during the operation by a suitable metal shield or case, strong enough to eliminate danger if any breakage occurs.

Preferred forms of centrifuge shall have a diameter of swing (tip to tip of whirling tubes) of 15 to 17 in. and a speed of at least 1500 r.p.m. or equivalent. If the available centrifuge has a diameter of swing varying from these limits, it shall be run at the proper speed to give the same centrifugal force at the tips of the tubes as that obtained with the preferred form of centrifuge. The proper speed shall be calculated from the following formula in which D represents the diameter of swing (tip to tip of whirling tubes) of the centrifuge used:

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[1] Criticisms of thisTentative Method are solicited and should be directed to Mr. R. P. Anderson, Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

$$\text{R.p.m.} = 1500 \sqrt{\frac{16}{D}}$$

Centrifuge Tubes.

4. *Centrifuge Tubes, A.S.T.M. Type.*—These tubes shall be made of suitable glass and thoroughly annealed. The total capacity shall be about 125 cc. and the mouth shall be suitably constricted for closing with a cork. The graduations shall be clear and distinct, reading upward from the bottom of the tube as follows:

RANGE.	SCALE DIVISIONS.	LIMIT OF ERROR.	NUMBERED.
0 - 0.5 cc.	0.05 cc.	0.02 cc.	½ cc.
0.5 - 3 "	0.1 "	0.05 "	1, 2, 3 "
3 - 5 "	0.5 "	0.2 "	4, 5 "
5 - 10 "	1.0 "	0.5 "	6, 8, 10 "
10 - 25 "	5.0 "	1.0 "	15, 20, 25 "
50 - 100 "	50.0 "	1.0 "	50, 100 "

The shape is optional provided it does not conflict with the other requirements.

Diluent.

5. (*a*) Petroleum naphtha conforming to the following requirements shall be used for the diluent.

Gravity, deg. A.P.I. at 60° F.	70 to 73
Aniline Point, deg. Centigrade	58 to 60
Initial Boiling Point, A.S.T.M.	not less than 122° F. (50° C.)
50-per-cent point, A.S.T.M.	158 to 176° F. (70 to 80° C.)
End Point, A.S.T.M.	not more than 266° F. (130° C.)

(*b*) The initial boiling point, the 50-per-cent point, and the end point of the petroleum naphtha shall be determined in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials.[1]

(*c*) The aniline point of the petroleum naphtha shall be determined as follows: Measure 10 cc. of the sample and 10 cc. of the aniline (freshly distilled, free from aminothiophenes) into a large test tube fitted with a stirrer and a thermometer. Heat the mixture by means of a naked flame until it becomes homogeneous, and then allow to cool until it becomes turbid. Raise the temperature slightly and make a duplicate determination. Disregard any slight initial turbidity, taking the temperature when the solution becomes completely cloudy. If the aniline point is more than 10° C. above the room temperature, use another larger test tube to form an air jacket.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378.

PROCEDURE

Preparing for Centrifuging.

6. Exactly 10.0 cc. of the oil to be tested shall be measured in each of two clean and dry centrifuge tubes at room temperature. Each tube shall be filled to the 100-cc. mark with the prescribed diluent and closed tightly with a softened cork (not a rubber stopper). Each tube shall then be inverted at least 20 times, allowing the liquid to drain thoroughly from the tapered tip of the tube each time. The tubes shall then be placed in a water bath at 90 to 95° F. for five minutes. The corks shall be momentarily removed to relieve any pressure and each tube shall again be inverted at least 20 times exactly as before. The success of this method depends to a large degree upon having a thoroughly homogeneous mixture which will drain quickly and completely from the tapered tip when the tube is inverted.

Centrifuging.

7. The two centrifuge tubes shall then be placed in the centrifuge on opposite sides and shall be whirled at a rate of 1400 to 1500 r.p.m. or equivalent for 10 minutes. The volume of sediment at the bottom of each tube shall be read and recorded, estimating to 0.05 cc. if possible. The tubes shall then be replaced in the centrifuge, again whirled for 10 minutes as before, and removed for reading the volume of the sediment as before. This operation shall be repeated until the volume of sediment in each tube remains constant for three consecutive readings. In general, not more than four whirlings are required for oils having a low precipitation number.

Precipitation Number.

8. The volume of the solid sediment at the bottom of each centrifuge tube shall be read, estimating to 0.1 cc. or closer if possible. If the two readings differ by not more than 0.1 cc. the mean of the two shall be reported as the "A.S.T.M. Precipitation Number." If the two readings differ by more than 0.1 cc. two more determinations shall be made and the average of the four determinations shall be reported.

ACCURACY

Accuracy.

9. With care and proper attention to details, duplicate determinations of precipitation number by this method should not differ by more than 0.1, provided the centrifuge tubes are accurate and readable to this degree.

TENTATIVE METHOD OF TEST

FOR

SULFUR IN MOTOR FUELS, NAPHTHAS AND ILLUMINATING OILS[1] (LAMP METHOD)

A.S.T.M. Designation: D 90 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1921; REVISED, 1924, 1926, 1929.

Scope.

1. This method is intended to cover the determination of sulfur in gasolines and other volatile motor fuels, in illuminating oils, and in petroleum naphthas. It is not strictly applicable to mixtures containing carbon bisulfide.

NOTE.—When this method is applied to mixtures containing carbon bisulfide approximately 85 per cent of the sulfur present as carbon bisulfide is usually determined.

APPARATUS

Apparatus.

2. The apparatus shall consist of the following:

(*a*) *Absorber.*—An absorber of chemically-resistant glass conforming to the dimensions shown in Fig. 1. The larger of the two bulbs of the absorber shall be filled at least two-thirds full with pieces of chemically-resistant glass rod from 8 to 10 mm. in length and from 5 to 6 mm. in diameter, or with perforated beads of chemically resistant glass 5 to 8 mm. in diameter.

(*b*) *Chimney.*—A chimney of chemically-resistant glass conforming to the dimensions shown in Fig. 1, and connected with the absorber by a cork stopper.

(*c*) *Spray Trap.*—A spray trap of chemically-resistant glass conforming to the dimensions shown in Fig. 1, and connected with the absorber by a cork or by a rubber stopper.

(*d*) *Lamp.*—A small lamp of about 25-cc. capacity. The lamp may conveniently consist of a 25 to 35-cc. Erlenmeyer flask, preferably of the dimensions shown in Fig. 1, and a cork carrying a piece of

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. R. P. Anderson, Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

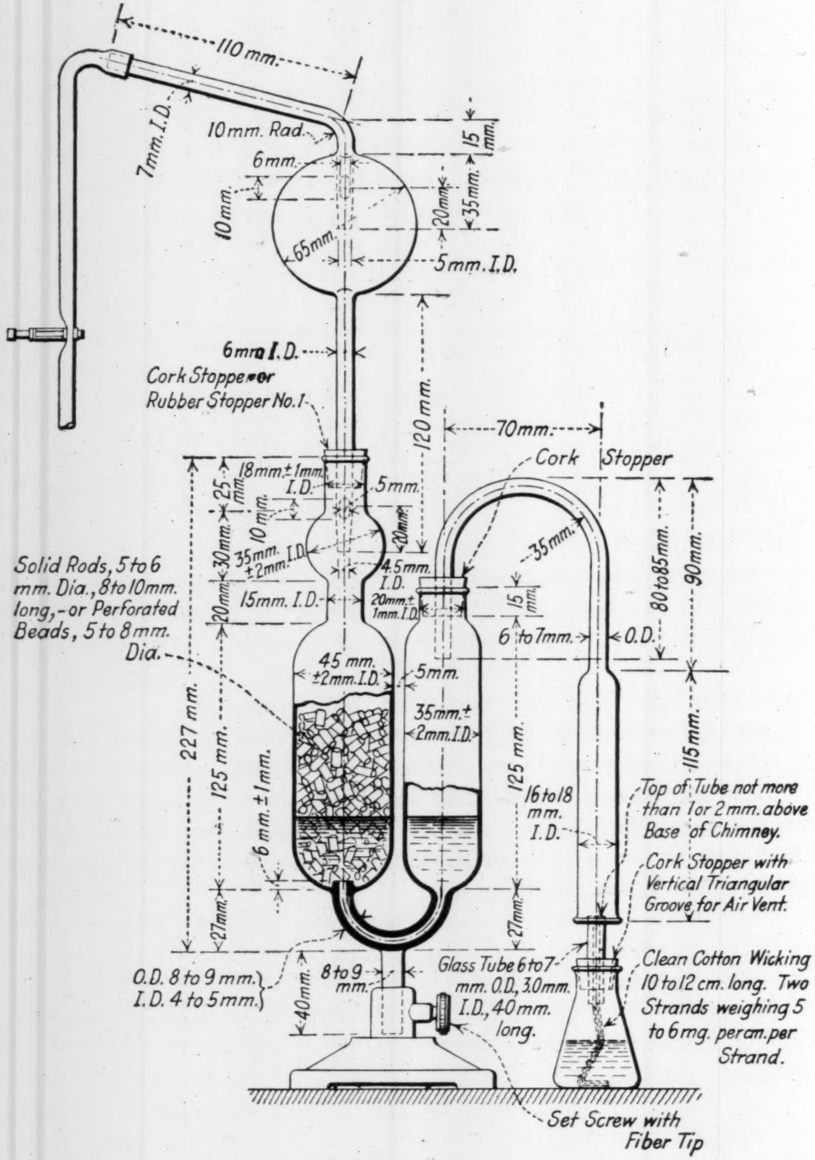
110 mm.
7mm. I.D.
10 mm. Rad.
6 mm.
10 mm.
65 mm.
15 mm.
20 mm.
35 mm.
5 mm. I.D.
6 mm I.D.
Cork Stopper or Rubber Stopper No.1
120 mm.
70 mm.
Cork Stopper
18 mm. ± 1 mm. I.D.
5 mm.
25 mm.
10 mm.
20 mm.
30 mm.
35 mm. ± 2 mm. I.D.
4.5 mm. I.D.
20 mm.
15 mm. I.D.
20 mm. ± 1 mm. I.D.
35 mm.
15 mm.
6 to 7 mm.
O.D.
80 to 85 mm.
90 mm.
Solid Rods, 5 to 6 mm. Dia., 8 to 10 mm. long, - or Perforated Beads, 5 to 8 mm. Dia.
45 mm. ± 2 mm. I.D.
5 mm.
35 mm. ± 2 mm. I.D.
227 mm.
125 mm.
6 mm. ± 1 mm.
125 mm.
16 to 18 mm. I.D.
115 mm.
Top of Tube not more than 1 or 2 mm. above Base of Chimney.
Cork Stopper with Vertical Triangular Groove for Air Vent.
27 mm.
27 mm.
O.D. 8 to 9 mm.
I.D. 4 to 5 mm.
8 to 9 mm.
40 mm.
Glass Tube 6 to 7 mm. O.D., 3.0 mm. I.D., 40 mm. long.
Clean Cotton Wicking 10 to 12 cm. long. Two Strands weighing 5 to 6 mg. per cm. per Strand.
Set Screw with Fiber Tip

FIG. 1.—Apparatus for Determination of Sulfur in Oils.

glass tubing 40 mm. in length, from 6 to 7 mm. in outside diameter, and 3 mm. in inside diameter, with ends ground or fused level. The wick tube should project above the cork at least 10 mm., and the cork shall have a vertical groove in its side so that air may enter the flask to replace the oil as it is consumed.

(*e*) *Cotton Wicking.*—Two strands of clean, unused cotton wicking, 10 to 12 cm. in length and weighing about 5 to 6 mg. per cm. per strand.

(*f*) *Filter Pump.*—A filter pump or other means for continuous suction.

SOLUTIONS REQUIRED

Solutions Required.

3. (*a*) *Hydrochloric Acid.*—Prepare a solution of HCl in distilled water which will contain 2.275 g. of HCl per liter and check carefully for accuracy.

(*b*) *Sodium Carbonate.*—Dissolve 3.306 g. of Na_2CO_3 in one liter of distilled water. Ten cubic centimeters of this solution should neutralize exactly 10 cc. of the HCl solution.

(*c*) *Methyl Orange.*—Dissolve 0.004 g. of methyl orange in one liter of distilled water.

PROCEDURE

Procedure.

4. The sulfur shall be determined as follows:

(*a*) Pass two strands of the new cottom wicking through the wick tube so that they are not twisted but are parallel in the wick tube. Pour into the clean, dry lamp about 15 cc. of the oil to be tested, and insert the cork containing the wick tube. After the wick has become saturated with the oil, trim it off as nearly as possible to the top of the wick tube with a pair of sharp scissors, finally adjusting the wick height by touching the top of it with the tip of a finger. Weigh the oil and lamp assembly to the nearest 0.001 g. Run a blank determination at the same time and under the same conditions by burning sulfur-free alcohol in a similar lamp. Thoroughly rinse out the absorber with distilled water, and put into it exactly 10 cc. of the sodium carbonate solution from an accurately calibrated pipette, and then dilute the solution with 10 cc. of distilled water. Rinse out also the chimney and the spray trap with distilled water, dry the chimney, and connect both to the absorber as shown in Fig. 1. Prepare the apparatus for the blank determination in the same manner putting into it exactly 10 cc. of the sodium carbonate solution and 10 cc. of distilled water. Apply gentle suction to both absorbers; light both the oil lamp and the alcohol lamp and then place them in position under the chimneys so that the top of each wick tube extends into the chimney not more than 1 or 2 mm. above the edge. Use a sulfur-free flame, such as an alcohol lamp for lighting the lamps; do not use matches. Adjust the suction so that a steady flame 12 to 18 mm. in height and free from smoking is obtained (Note 1). The suction shall be adjusted so that air is drawn through both absorbers at approximately the same rate. The maintenance of proper flame height usually requires that the wick be flush with the top of the wick tube for naphthas or motor fuels and a little higher for illuminating oils. The room shall be free from draughts. Continue burning for from one to one and one-half hours, or less if the sulfur content of the oil is high. During this time the oil should be consumed at the rate of about 2 to 2.5 g. per hour.

(*b*) Extinguish the flames and stop the suction on both absorbers. Weigh the oil lamp immediately to the nearest 0.001 g., and determine by difference the weight of oil consumed. Working with the blank first, disconnect the spray trap and chimney and wash them thoroughly with the methyl orange solution, using a wash bottle with a very fine jet and collecting the washings in the absorber. Use approximately 35 cc. of the solution for washing. Carefully titrate the faintly-yellow solution with the HCl solution. During titration, carefully agitate the contents of the absorber either by alternate sucking and blowing through a rubber tube held between the lips, or else by the use of a suitable rubber-syringe bulb. As the end point is approached, draw the liquid back and forth between the bulbs after each addition of acid, agitating as before. When the first permanent pink color appears, the end point has been reached. Read and record the volume of HCl solution used (Note 2).

(*c*) Rinse the chimney and the spray trap used in the actual determination into the absorber to which they were connected, exactly as has been prescribed for the blank. If at this point the solution in the absorber should have a pink color, too much oil has been burned and the determination shall be repeated, but burning for a shorter time. The temporary pink color that sometimes appears in the chimney when rinsing it out should be disregarded. Titrate just as in the blank, continuing to add the HCl solution until the color matches that obtained in the blank. Read and record the volume of HCl solution used.

NOTE 1.—If it is not possible to obtain a good flame free from smoking, as sometimes happens if the oil contains considerable percentages of benzol, dilute the oil with an equal weight of sulfur-free anhydrous alcohol before putting the sample into the lamp. If, while maintaining the specified flame height the flame still smokes, a smaller flame is permissible. In order to get the correct value when calculating the percentage of sulfur present in this case, allowance shall be made for the fact that the sample as burned in the lamp is one-half alcohol. This shall be done by doubling the percentage of sulfur obtained in computation by the formula given in Section 5.

NOTE 2.—For accurate work, conditions shall be such that a minimum or zero blank is obtained. If the titration of the blank requires more than 0.1 cc. of the HCl solution per gram of sample burned, which corresponds to 0.01 per cent of sulfur, a high degree of accuracy cannot be expected in the case of oils of low sulfur content.

Calculation.

5. Calculate the sulfur content of the oil by substituting the proper values in the following formula:

$$\text{Percentage of sulfur} = \frac{\begin{matrix}\text{cubic centimeters}\\ \text{of HCl for blank}\end{matrix} - \begin{matrix}\text{cubic centimeters}\\ \text{of HCl for sample}\end{matrix}}{\text{grams of oil burned} \times 10}$$

This formula is correct only for the standard solutions specified in Section 3, 1 cc. of each being equivalent to 0.001 g. of sulfur. The use of solutions of any other strength, such as 0.1 *N*, involves more complicated calculation and is not advisable.

Check Determination.

6. As a check on the determination, a sample of known sulfur content shall be analyzed. Such a reference sample may be made by adding a pure volatile sulfur compound, such as carbon bisulfide, to sulfur-free anhydrous alcohol. This check shall indicate from 85 to 100 per cent of the sulfur present.

TENTATIVE SPECIFICATIONS

FOR

GRAVEL FOR BITUMINOUS CONCRETE BASE[1]

A.S.T.M. Designation: D 309 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. These specifications cover ¼ to 1¼-in. and ¼ to 2½-in. size gravel, either of which sizes is suitable for use in the construction of a bituminous concrete base prepared by the mixing method and upon which may be placed any type of surface course.

General Characteristics. 2. The gravel shall consist of hard, sound,[2] tough, durable stone particles, either crushed or uncrushed, and shall be free from injurious amounts of adherent coatings and soft, thin, elongated or laminated pieces, or other deleterious substances.

Abrasion. 3. Gravel shall show a satisfactory resistance to abrasion as measured by an acceptable abrasion test for gravel.

NOTE.—No test limits for abrasion are specified due to the status of knowledge concerning suitable specification limits for this test. Many engineers feel that the quality of gravel may be indicated by the results of an abrasion test, and accordingly the Tentative Method of Test for Abrasion of Gravel (A.S.T.M. Designation: D 289 - 28 T) of the American Society for Testing Materials[3] is recommended.

Deleterious Substances. 4. The amount of deleterious substances shall not exceed the following maximum requirements:

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-4 on Road and Paving Materials, 441 Lexington Ave., New York City.

[2] No suitable test for soundness of gravel has been developed, although the committee is carrying out work looking forward to the development of such a test. An accelerated test using sodium sulfate has been proposed for use with crushed stone (see Proposed Method of Test for Soundness of Coarse Aggregate, *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 361 (1928)), but without a modification in the procedure this test is not considered suitable for a heterogeneous material such as gravel.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 940 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 471.

	PER CENT BY WEIGHT
Removed by decantation	1
Shale	1
Coal	1
Clay lumps	0.5
Soft fragments	5
Total shale, coal, clay lumps and soft fragments	5
Other local deleterious substances (such as alkali, friable, thin, or elongated or laminated pieces)	....

NOTE.—It is recognized that under certain conditions percentages of deleterious substances less than those shown in the table should be specified as a maximum.

5. The gravel when tested by means of laboratory screens shall conform to the following requirements: **Size.**

¼ TO 1¼-IN. SIZE		PER CENT
Passing 1½-in. screen		100
Passing 1¼-in. screen	not less than	95
Passing ¾-in. screen		40 to 75
Passing ¼-in. screen	not more than	5

¼ TO 2½-IN. SIZE		PER CENT
Passing 3-in. screen		100
Passing 2½-in. screen	not less than	95
Passing 1¼-in. screen		40 to 75
Passing ¾-in. screen		10 to 25
Passing ¼-in. screen	not more than	5

6. The method of sampling shall conform to the Standard Methods of Sampling Stone, Slag, Gravel, Sand and Stone Block for Use as Highway Materials, Including Some Material Survey Methods (A.S.T.M. Designation: D 75) of the American Society for Testing Materials.[1] **Sampling.**

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 473.

TENTATIVE SPECIFICATIONS
FOR
BROKEN STONE FOR WATERBOUND BASE[1]

A.S.T.M. Designation: D 190 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1924; REVISED, 1929.

Scope.

1. These specifications cover the quality and grading of broken stone and stone screenings for use in a waterbound broken stone base course which is to be covered with any type of surface.

NOTE.—The test values for quality of stone incorporated in these specifications are suggested as the lowest safe requirements. It is not expected, however, that the limits for size and quality will be applicable to all localities and conditions.

General Characteristics.

2. The broken stone shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces.

3. Stone for screenings shall be of suitable binding quality.

Physical Properties.

4. The stone shall conform to the following requirement:

Percentage of wear	not more than 8

Coarse Aggregate.

5. The coarse aggregate shall be of either (1) the 1¼ to 2½-in. size (2) the 2½ to 3½-in. size or (3) the 2½ to 4½-in. size, and shall be well graded between the limits specified. When tested by means of laboratory screens, it shall conform to the following requirements:

1¼ TO 2½-IN. SIZE

Passing 1¼-in. screen	0 to 15 per cent
Passing 2½-in. screen	95 to 100 "

2½ TO 3½-IN. SIZE

Passing 2½-in. screen	0 to 15 per cent
Passing 3½-in. screen	95 to 100 "

2½ TO 4½-IN. SIZE

Passing 2½-in. screen	0 to 15 per cent
Passing 4½-in. screen	95 to 100 "

NOTE.—Any one of the above sizes or a combination thereof may be specified as desired.

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-4 on Road and Paving Materials, 441 Lexington Ave., New York City.

Screenings. 6. The screenings shall be of either (1) the 0 to ¼-in. size, or (2) the 0 to ¾-in. size, well-graded from coarse to fine and free from dirt or other foreign material. When tested by means of laboratory screens it shall conform to the following requirements:

0 TO ¼-IN. SIZE	
Passing ¼-in. screen	85 to 100 per cent
0 TO ¾-IN. SIZE	
Passing ¼-in. screen	40 to 80 per cent
Passing ¾-in. screen	95 to 100 "

NOTE.—Either of the above alternate sizes may be specified as desired.

Methods of Testing. 7. (*a*) The percentage of wear shall be determined in accordance with the Standard Method of Test for Abrasion of Rock (A.S.T.M. Designation: D 2) of the American Society for Testing Materials.[1]

(*b*) Determinations of size shall be made in accordance with the Standard Method of Mechanical Analysis of Broken Stone or Broken Slag, Except Aggregates Used in Cement Concrete (A.S.T.M. Designation: D 18) of the American Society for Testing Materials.[2]

Methods of Sampling. 8. The methods of sampling shall conform to the Standard Methods of Sampling Stone, Slag, Gravel, Sand and Stone Block for Use as Highway Materials, Including Some Material Survey Methods (A.S.T.M. Designation: D 75) of the American Society for Testing Materials.[3]

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 463.

[2] *Ibid.*, p. 481.

[3] *Ibid.*, p. 473

TENTATIVE SPECIFICATIONS
FOR
BROKEN STONE FOR BITUMINOUS CONCRETE BASE[1]

A.S.T.M. Designation: D 193 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1924; REVISED, 1929.

Scope.

1. These specifications cover the quality and grading of broken stone to be used in the construction of a closed mix and an open mix bituminous concrete base.

General Characteristics.

2. The broken stone shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces.

Physical Properties.

3. The stone shall conform to the following requirements.

Percentage of wear	not more than 7
Toughness	not less than 6

Coarse Aggregate for Open Mix Bituminous Concrete Base.

4. The coarse aggregate for open mix bituminous concrete base shall consist of the 1¼ to 2½-in. size and shall be well graded between these limits. When tested by means of laboratory screens it shall conform to the following requirements:

Passing 1¼-in. screen	0 to 15 per cent
Passing 2½-in. screen	95 to 100 "

Coarse Aggregate for Closed Mix Bituminous Concrete Base.

5. The coarse aggregate for closed mix bituminous concrete base shall consist of the ¼ to 2½-in. size and shall be well graded between these limits. When tested by means of laboratory screens it shall conform to the following requirements:

Passing ¼-in. screen	0 to 5 per cent
Passing 1¼-in. screen	25 to 75 "
Passing 2½-in. screen	95 to 100 "

Methods of Testing.

6. (*a*) The percentage of wear shall be determined in accordance with the Standard Method of Test for Abrasion of Rock (A.S.T.M. Designation: D 2) of the American Society for Testing Materials.[2]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-4 on Road and Paving Materials, 441 Lexington Ave., New York City.

[2] 1927 Book of A.S.T.M. Standards, **Part II,** p. 463.

(*b*) The toughness shall be determined in accordance with the Standard Method of Test for Toughness of Rock (A.S.T.M. Designation: D 3) of the American Society for Testing Materials.[1]

(*c*) Determinations of size shall be made in accordance with the Standard Method of Mechanical Analysis of Broken Stone or Broken Slag, Except Aggregates Used in Cement Concrete (A.S.T.M. Designation: D 18) of the American Society for Testing Materials.[2]

Methods of Sampling.

7. The methods of sampling shall conform to the Standard Methods of Sampling Stone, Slag, Gravel, Sand and Stone Block for Use as Highway Materials, Including Some Material Survey Methods (A.S.T.M. Designation: D 75) of the American Society for Testing Materials.[3]

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 464.

[2] *Ibid.*, p. 481.

[3] *Ibid.*, p. 473.

TENTATIVE METHOD OF TEST
FOR
SIZE OF ANTHRACITE[1]

A.S.T.M. Designation: D 310 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. This method of test covers the screen tests of anthracite to determine the percentage of undersize or oversize in any given commercial size.

APPARATUS

Screens. 2. The screens for testing the various sizes of anthracite shall consist of No. 16 U. S. gage metal plates with staggered round openings. Screens mounted in hardwood box frames 16 to 20 in. square are satisfactory for testing chestnut, pea, and buckwheat sizes of anthracite. For broken, egg, and stove sizes it is more convenient to use screens square or rectangular in shape having an area of 4 to 6 sq. ft. The screens may conveniently be mounted on a rack, so as to slide like a drawer, with a pan underneath to catch the undersize.

Screen Openings. 3. The screen openings for testing the different commercial sizes of anthracite[2] shall be as follows:

SIZE	SIZE OF ROUND-HOLE OPENINGS IN TESTING SCREENS
Broken	Passing a $4\frac{7}{16}$-in. screen, retained on a $3\frac{7}{16}$-in. screen
Egg	Passing a $3\frac{7}{16}$-in. screen, retained on a $2\frac{8}{16}$-in. screen
Stove	Passing a $2\frac{8}{16}$-in. screen, retained on a $1\frac{9}{16}$-in. screen
Chestnut	Passing a $1\frac{9}{16}$-in. screen, retained on a $\frac{11}{16}$-in. screen
Pea	Passing a $\frac{12}{16}$-in. screen, retained on a $\frac{8}{16}$-in. screen
No. 1 Buckwheat	Passing a $\frac{9}{16}$-in. screen, retained on a $\frac{5}{16}$-in. screen
No. 2 Buckwheat (Rice)	Passing a $\frac{5}{16}$-in. screen, retained on a $\frac{3}{16}$-in. screen
No. 3 Buckwheat (Barley)	Passing a $\frac{3}{16}$-in. screen, retained on a $\frac{3}{32}$-in. screen

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[1] **Criticisms of this Tentative Method are solicited and should be directed to Mr. W. A. Selvig, Secretary of Committee D-5 on Coal and Coke, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.**

[2] The names of anthracite sizes and the size of screen openings for broken, egg, stove, chestnut, and pea sizes are in conformity with those recommended by the Anthracite Operators' Conference of June 8, 1928.

Tolerances of ± 3 per cent on average openings and of 10 per cent in maximum openings are permissible.

SAMPLING

4. Each carload, or its equivalent, shall be considered as a unit for sampling. **Unit for Sampling.**

5. The gross sample shall not be less than 200 lb. for broken and egg sizes, and not less than 100 lb. for stove, chestnut, pea, and the buckwheat sizes. **Gross Sample.**

6. (*a*) The gross sample shall preferably be collected when the coal is being loaded or unloaded in accordance with the procedure described in Sections 1 and 2 of the Standard Method of Sampling Coal (A.S.T.M. Designation: D 21) of the American Society for Testing Materials.[1] The increments shall be regularly and systematically collected, so that the entire quantity of coal sampled will be represented proportionately in the gross sample, and with such frequency that a gross sample of the required amount shall be collected. **Method of Sampling.**

(*b*) In case it is necessary to collect the sample from the exposed surface of the car, at least nine equal increments shall be taken about one foot below the surface at regular intervals along three parallel lines running from one end of the car to the other. One of these lines shall pass through the center of the car and each of the other lines shall be about two-thirds the distance from the center line to the side of the car.

7. For broken, egg, stove, and chestnut sizes the gross sample shall be screened without being mixed or reduced. For pea and the buckwheat sizes the gross sample shall be thoroughly mixed and reduced by quartering, without crushing, in accordance with Sections 6 and 7 of the Standard Method of Sampling Coal (A.S.T.M. Designation: D 21) of the American Society for Testing Materials[1] to a laboratory sample of the following approximate minimum amounts: **Laboratory Sample.**

SIZE	LABORATORY SAMPLE APPROXIMATE MINIMUM WEIGHT
Pea	50 lb.
No. 1 Buckwheat	25 lb.
No. 2 Buckwheat (Rice)	10 lb.
No. 3 Buckwheat (Barley)	5 lb.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 530

PROCEDURE

Procedure. 8. In case the coal is wet it shall be air-dried before screening. The undersize shall be determined first. For broken, egg, and stove sizes, each piece shall be upended on the screen, that is, tested to see if it will in any position pass through the screen. For chestnut, pea, and the buckwheat sizes, the screens shall be shaken gently, so as to avoid breakage of the coal, with a reciprocating horizontal motion until practically no more coal will pass through the openings. The coal shall be screened in such increments as will allow the pieces to be in direct contact with the screen openings after the completion of the shaking of each increment.

Report. 9. The undersize and oversize shall be reported to the nearest 1 per cent.

TENTATIVE METHOD OF TEST
FOR
SIEVE ANALYSIS OF CRUSHED BITUMINOUS COAL[1]

A.S.T.M. Designation: D 311 - 29 T

This is a Tentative Standard, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. This method is intended for the rather coarsely crushed coal, less than 1½ in. in size, such as is charged into coke ovens. It does not apply to powdered coal as used in boiler plants.

APPARATUS

Sieves. 2. The following square-mesh sieves, so selected that the actual openings between the wires of the succeeding sizes of sieves shall have a constant ratio of 1.414 (the square root of 2), shall be used: 0.131, 0.185, 0.263, 0.371, 0.525, 0.742 and 1.050 in. Tolerances of ± 5 per cent on average openings and of 15 per cent in maximum openings are permissible.[2] Sieves of double-crimped wire with circular frames about 18 in. in diameter are satisfactory.

SAMPLING

Gross Sample. 3. For collecting gross samples of crushed bituminous coal, the procedure described in Sections 1 to 4, inclusive, and the directions preceding Section 1 of the Standard Method of Sampling Coal (A.S.T.M. Designation: D 21) of the American Society for Testing Materials[3] shall apply.

Laboratory Sample. 4. The gross sample of coal shall be thoroughly mixed and reduced by quartering, without crushing, to a laboratory sample of approximately 60 lb. in accordance with Sections 6 and 7 of the Standard

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. W. A. Selvig, Secretary of Committee D-5 on Coal and Coke, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.

[2] For methods of testing sieves see the Standard Specifications for Sieves for Testing Purposes (A.S.T.M. Designation: E 11), 1927 Book of A.S.T.M. Standards, Part II, p. 917.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 530.

Method D 21.[1] In case the coal is wet, the gross sample shall be air-dried before reduction to the 60-lb. laboratory sample.

PROCEDURE

Procedure.

5. The laboratory sample (approximately 60 lb.) shall be accurately weighed. Starting with the sieve having the largest opening, the laboratory sample of coal shall be sieved in such increments as will allow the pieces to be in direct contact with the meshes after the completion of the shaking of each increment. In sieving, the coal shall be shaken rather vigorously, in order to upend the pieces, until practically no more coal will pass through the openings. The coal retained on each sieve and that which passes the smallest sieve shall be weighed separately.

Report.

6. The sieve analysis of the coal shall be reported in percentage to the nearest 0.1 per cent as follows:

	PER CENT
Retained on a 1.050-in. sieve	....
Passing a 1.050-in. sieve, retained on a 0.742-in. sieve	....
Passing a 0.742-in. sieve, retained on a 0.525-in. sieve	....
Passing a 0.525-in. sieve, retained on a 0.371-in. sieve	....
Passing a 0.371-in. sieve, retained on a 0.263-in. sieve	....
Passing a 0.263-in. sieve, retained on a 0.185-in. sieve	....
Passing a 0.185-in. sieve, retained on a 0.131-in. sieve	....
Passing a 0.131-in. sieve	....
Total	100.0

In case the sum of the percentages does not total 100.0, correction shall be made on the quantity passing through the smallest sieve so that the total will be 100.0. However, if the sum of the weights retained on each sieve and that which passes the smallest sieve shows a loss of over 0.5 per cent, the analysis shall be rejected and another test made.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 530.

TENTATIVE DEFINITIONS
OF
TERMS RELATING TO TIMBER[1]

A.S.T.M. Designation: D 9 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

DEFINITION OF STRUCTURAL TIMBER

By the term "Structural Timber" is understood all such products of wood in which the strength of the timber is the controlling element in their selection and use. The following is a list of products considered as structural timbers:

Trestle Timbers.—Stringers, caps, posts, mud sills, bracing, bridge ties, guard rails.

Car Timbers.—Car framing, including upper framing; car sills.

Framing for Buildings.—Posts, mud sills, girders, framing joists.

Ship Timbers.—Ship timbers, ship decking.

Cross Arms for Poles.

DEFINITIONS OF TERMS RELATING TO WOOD

Annual Ring.—In the case of wood, the growth layer put on in a single growth year.

Heartwood.—The inner, dead portion of the wood in a tree.

NOTE.—It is usually dark in color. In trees like white spruce, hemlock, white fir, basswood, and holly, the heartwood is not distinctly darker than the sapwood, and the two can not be readily distinguished.

Sapwood.—The outer, live portion of the wood in a tree.

NOTE.—It is usually light in color.

Springwood.—The softer, more porous portion of each annual ring.

Summerwood.—The harder, less porous portion of each annual ring.

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[1] Criticisms of these Tentative Definitions are solicited and should be directed to Mr. J. A. Newlin, Secretary of Committee D-7 on Timber, U. S. Forest Products Laboratory, Madison, Wis.

These definitions, when adopted as standard, will supersede the present Standard Definitions of Terms Relating to Structural Timber (A.S.T.M. Designation: D 9 - 15), 1927 Book of A.S.T.M. Standards, Part II, p. 697.

NOTE.—In softwoods it is darker than the springwood, but not always so in hardwoods. If the annual rings are fairly uniform in texture, as in maple, red gum, and yellow poplar, no distinction can be made between springwood and summerwood.

Pith.—In the case of wood, the small soft core occurring in the structural center.

STANDARD DEFECTS

Methods of measurement of size of knots or holes in the Use-Classifications of Joist and Plank, Beams and Stringers, and Posts and Timbers, are given in the Standard Specifications for Structural Wood Joist, Planks, Beams, Stringers and Posts (A.S.T.M. Designation: D 245) of the American Society for Testing Materials.[1]

Defect.—In the case of wood, any irregularity occurring in or on the wood that may lower its strength.

Blemish.—In the case of wood, anything, not necessarily a defect, marring its appearance.

Bark Pocket.—Bark partially or wholly enclosed in wood.

Check.—In the case of wood, a separation along the grain, the greater part of which occurs across the rings of annual growth.

End Check.—A check occurring at an end of a piece.

Heart Check.—A check starting near the pith and extending toward but not to the surface of a piece.

NOTE.—Several of these occurring together are called a star check.

Surface Check.—A check occurring at the surface of a piece.

Through Check.—A check extending through the piece from one surface to an opposite or to an adjoining surface.

Collapse.—In the case of wood, a caving at a surface of a piece.

NOTE.—It sometimes occurs in streaks, giving the surface a corrugated appearance and often is due to the flattening of the cells when wet wood is dried quickly.

Honeycombing.—In the case of wood, checks that occur in the interior of a piece, often not visible at the surface.

NOTE.—On a cross-section they usually appear as slits or pockets the width of which may be very large relative to the radial length.

Cross Break.—A separation of the wood cells across the grain.

NOTE.—Such breaks may be due to internal strains resulting from unequal shrinkage or to external forces.

Cross-Grained Wood.—Wood in which the fibers are not parallel with the axis of a piece.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 581.

Curly-Grained Wood.—Wood in which the fibers are distorted so that they afford a curled appearance, as in "bird's eye" wood.

NOTE.—Areas showing curly grain may vary up to several inches in diameter.

Diagonal-Grained Wood.—Wood in which the fibers are at an angle with (that is, diagonal to) the axis of a piece as a result of sawing at an angle with the axis of the tree.

NOTE.—It may appear on either the radial or flat-grain surface.

Dip-Grained Wood.—Wood which has single waves or undulations of the fibers, such as occur around knots and pitch pockets.

Interlocked-Grained Wood.—Wood in which the fibers are inclined in one direction in a number of rings of annual growth, then gradually reverse and are inclined in an opposite direction in succeeding growth rings, then later again reverse, etc.

Spiral-Grained Wood.—Wood in which the fibers take a more or less winding or spiral course, as in a twisted tree.

NOTE.—It may be detected on the flat grain surface.

Wavy-Grained Wood.—Wood in which the fibers collectively take the form of waves or undulations.

NOTE.—It may appear on either the radial or flat-grain surface and is indicated by the wavy surface of a split piece.

Decay.—In the case of wood, destruction of the wood substance due to the action of wood-destroying fungi.

NOTE.—"Dote" and "rot" are synonymous with "decay" and are any form of decay which may be evident either as a dark red discoloration not found in the sound wood, or the presence of white or red rotten spots.

Advanced (or Typical) Decay.—In the case of wood, the older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ring-shaked, pitted or crumbly.

NOTE.—Decided discoloration or bleaching of the rotted wood is often apparent as, for example, brown and white rots, pocket rots.

Incipient Decay.—In the case of wood, the early stage of decay which has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood.

NOTE.—It is usually accompanied by a slight discoloration or bleaching of the wood as instanced by the "firm red heart" in softwoods and the "water-soak" stage in certain types of decay.

Firm Red Heart.—A stage of incipient decay in wood characterized by a reddish color produced in the heartwood, which does not, however, make the wood unfit for the majority of yard purposes.

NOTE.—It is caused by the fungus Trametes pini and occurs chiefly in the pines.

Water-Soak (or Stain).—A term applied to a generally water-soaked area in heartwood, which is usually interpreted as the incipient stage of certain wood decays.

NOTE.—It occurs in hemlock and possibly in other woods.

Knot.—In the case of wood, that portion of a branch which has become incorporated in the body of a tree.

Pin Knot.—A pin knot is one not over ½ in. in diameter.

Small Knot.—A small knot is one over ½ in., but not over ¾ in., in diameter.

Medium Knot.—A medium knot is one over ¾ in., but not over 1½ in., in diameter.

Large Knot.—A large knot is one more than 1½ in. in diameter.

Encased Knot.—An encased knot is one whose growth rings are not intergrown and homogeneous with the growth rings of the piece it is in. The encasement may be partial or complete; if intergrown partially or so fixed by growth or position that it will retain its place in the piece, it shall be considered a tight knot; if completely intergrown on one face, it is a watertight knot.

Intergrown Knot.—An intergrown knot is one whose rings of annual growth are completely intergrown with those of the surrounding wood.

Loose Knot.—A loose knot is one not firmly held in place by growth or position.

Tight Knot.—A tight knot is one so fixed by growth or position that it will firmly retain its place in the piece.

Pith Knot.—A pith knot is a sound knot with a pith hole not more than ¼ in. in diameter in the center.

Round Knot.—A round knot is one which is oval or circular in form.

Spike Knot.—A spike knot is one sawn in a lengthwise direction.

Decayed Knot.—A decayed knot is one not as hard as the wood it is in, and contains advanced decay.

Sound Knot.—A sound knot is one which is solid across its face and which is as hard as the wood surrounding it; it may be either red or black.

Pitch Pockets.—Pitch pockets are openings between the grain of the wood containing more or less pitch or bark. These shall be classified as small, medium and large pitch pockets.

Small Pitch Pocket.—A small pitch pocket is one not over $\frac{1}{8}$ in. wide or not over 4 in. in length, or not over $\frac{1}{4}$ in. wide and not over 2 in. in length.

Medium Pitch Pocket.—A medium pitch pocket is one not over $\frac{3}{8}$ in. wide and 4 in. in length, or not over $\frac{1}{8}$ in. wide and not over 8 in. in length.

Large Pitch Pocket.—A large pitch pocket is one over $\frac{3}{8}$ in. wide and over 4 in. in length, or over $\frac{1}{8}$ in. wide and over 8 in. in length.

Pitch Streak.—A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well-defined streak, or where the fiber between grains, that is, the coarse-grained fiber, usually termed "springwood," is not saturated with pitch, it shall not be considered a defect.

Shake.—In the case of wood, a separation along the grain, the greater part of which occurs between the rings of annual growth.

Through Shake.—A shake which extends between two faces of a timber.

Sound Wood.—Wood free from any form of decay, incipient or advanced.

Wane.—Bark or lack of wood from any cause on edges of timbers.

STANDARD NAMES FOR STRUCTURAL TIMBERS

COMMERCIAL NAME	BOTANICAL NAME
	CEDARS
Alaska Cedar	Chamaecyparis nootkatensis
Northern White Cedar	Thuja occidentalis
Port Orford Cedar	Chamaecyparis lawsoniana
Southern White Cedar	Chamaecyparis thyoides
Western Red Cedar	Thuja plicata
	CYPRESS
Red Cypress	Taxodium distichum (Coast type)
Yellow Cypress	Taxodium distichum (Inland type)
White Cypress	Taxodium distichum (Inland type)
	DOUGLAS FIR
Douglas Fir	Pseudotsuga taxifolia (Coast type)
Red Fir	Pseudotsuga taxifolia (Intermountain type)
Red Fir	Pseudotsuga taxifolia (Rocky Mountain type)

Commercial Name	Botanical Name
The True Firs	
Balsam Fir	Abies balsamea
	Abies fraseri (Southern balsam fir)
Golden Fir	Abies magnifica
Noble Fir	Abies nobilis
Silver Fir	Abies amabilis
White Fir	Abies concolor
	Abies grandis (lowland white fir)
Hemlocks	
Eastern Hemlock	Tsuga canadensis
	Tsuga caroliniana (Carolina hemlock)
West Coast Hemlock	Tsuga heterophylla (Western hemlock)
Larch	
Western Larch	Larix occidentalis
Pines	
California White Pine	Pinus ponderosa (Western yellow pine)
	Pinus jeffreyi (Jeffrey pine)
Idaho White Pine	Pinus monticola
Northern White Pine	Pinus strobus
Norway Pine	Pinus resinosa
Pondosa Pine	Pinus ponderosa (Western yellow pine)
Southern Pine (Southern yellow pine)	Pinus taeda (loblolly pine)
	Pinus palustris (longleaf pine)
	Pinus serotina (pond pine)
	Pinus echinata (shortleaf pine)
	Pinus caribaea (slash pine)
	Pinus rigida (pitch pine)
	Pinus glabra (spruce pine)
Sugar Pine	Pinus lambertiana
Redwood	
Redwood	Sequoia sempervirens
Spruces	
Eastern Spruce	Picea mariana (black spruce)
	Picea rubra (red spruce)
	Picea glauca (white spruce)
Engelmann Spruce	Picea engelmanni
	Picea parryana (blue spruce)
Sitka Spruce	Picea sitchensis
Tamarack	
Tamarack	Larix laricina

TENTATIVE SPECIFICATIONS

FOR

ASPHALT FOR USE IN CONSTRUCTING BUILT-UP ROOF COVERINGS[1]

A.S.T.M. Designation: D 312 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. These specifications cover asphalt intended for use as hot cement and mopping coat in the construction of built-up roof coverings for roofs surfaced in various manners, laid either over boards or concrete on various inclines, in connection with the Standard Specifications for Asphalt-Saturated Roofing Felt for use in Waterproofing and in Constructing Built-Up Roofs (A.S.T.M. Designation: D 226)[2] or the Standard Specifications for Asphalt-Saturated Asbestos Felt for Use in Constructing Built-Up Roofs (A.S.T.M. Designation: D 250) of the American Society for Testing Materials.[3]

Types. 2. The asphalts covered by these specifications include steam-distilled and blown-petroleum asphalts and also include mixtures of native asphalts with petroleum asphalts, likewise steam-distilled and blown-petroleum asphalts or combinations thereof mixed with mineral matter. The purchaser shall reserve the right to select that type of asphalt which in his judgment is best suited for his particular requirements.

SAMPLING

Sampling. 3. The sampling shall be performed in accordance with the Standard Methods of Sampling Bituminous Materials (A.S.T.M. Designation: D 140) of the American Society for Testing Materials.[4]

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-8 on Bituminous Waterproofing and Roofing Materials, 441 Lexington Ave., New York City.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 736.

[3] *Ibid.*, p. 742. [4] *Ibid.*, p. 515.

PROPERTIES

Properties.

4. The asphalt shall be homogeneous and free from water. It shall conform to the following requirements:

(*a*) Softening Point (Ring-and-Ball Method):

For mineral-surfaced roofs with inclines up to 2 in. per ft. . 57 to 74° C. (135 to 165° F.)
For unsurfaced roofs with inclines up to 3 in. per ft. . . . . 66 to 93° C. (150 to 200° F.)
For unsurfaced roofs with inclines up to 6 in. per ft. . . . . 74 to 93° C. (165 to 200° F.)

(*b*) Penetration at 0° C. (32° F.), 200 g., 60 sec. . . . . not less than 5
(*c*) Penetration at 25° C. (77° F.), 100 g., 5 sec. . . . . 20 to 50
(*d*) Loss on heating at 163° C. (325° F.), 50 g., 5 hr. . . . . not more than 1.5 per cent
(*e*) Penetration at 25° C. (77° F.), 100 g., 5 sec. of residue after heating at 163° C. (325° F.) as compared with penetration of asphalt before heating. . . . . not less than 60 per cent
(*f*) Ductility at 25° C. (77° F.). . . . . not less than 3 cm.
(*g*) Soluble in carbon disulfide. . . . . not less than 65 per cent
(*h*) Ash on incineration. . . . . either 0 to 1 or 10 to 28 per cent, inclusive
(*i*) Soluble in carbon tetrachloride. . . . . not less than 99 per cent
(*j*) Elutriation test (Sediment). . . . . not more than 7 per cent

METHODS OF TESTING

Methods of Testing.

5. The properties enumerated in these specifications shall be determined in accordance with the following methods of test of the American Society for Testing Materials:

(*a*) *Softening Point:* Standard Method of Test for Softening Point of Bituminous Materials (Ring-and-Ball Method) (A.S.T.M. Designation: D 36).[1]

(*b*) *Penetration:* Standard Method of Test for Penetration of Bituminous Materials (A.S.T.M. Designation: D 5).[2]

(*c*) *Loss on Heating:* Standard Method of Test for Loss on Heating of Oil and Asphaltic Compounds (A.S.T.M. Designation: D 6).[3]

(*d*) *Ductility:* Tentative Method of Test for Ductility of Bituminous Materials (A.S.T.M. Designation: D 113 – 26 T).[4]

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[1] **1927 Book of A.S.T.M. Standards, Part II, p. 496.**

[2] ***Ibid.*, p. 493.**

[3] *Ibid.*, p. 489.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 886 (1926); also 1929 Book of A.S.T.M. Tentative Standards, p. 481.

(*e*) *Soluble in Carbon Disulfide:* Standard Method of Test for the Determination of Bitumen (A.S.T.M. Designation: D 4.)[1]

(*f*) *Ash:* Standard Methods of Laboratory Sampling and Analysis of Coal and Coke (A.S.T.M Designation: D 271).[2]

(*g*) *Soluble in Carbon Tetrachloride:* Standard Method of Test for the Determination of Proportion of Bitumen Soluble in Carbon Tetrachloride (A.S.T.M. Designation: D 165).[3]

(*h*) *Elutriation Test* (Sediment): Tentative Method of Test for Coarse Particles in Bituminous Materials by Means of Elutriation (A.S.T.M. Designation: D 313 - 29 T).[4]

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 484.

[2] 1929 Supplement to Book of A.S.T.M. Standards, p. 212.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 487.

[4] See p. 722.

TENTATIVE METHOD OF TEST

FOR

COARSE PARTICLES IN BITUMINOUS MATERIALS BY MEANS OF ELUTRIATION[1]

A.S.T.M. Designation: D 313 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope. 1. These methods cover the determination of the amount of relatively coarse particles of mineral or other insoluble matter in bituminous materials, which settle under the conditions prescribed.

Sampling. 2. The sampling shall be performed in accordance with the Standard Methods of Sampling Bituminous Materials (A.S.T.M. Designation: D 140) of the American Society for Testing Materials.[2]

Treatment of Sample. 3. The sample as received shall be completely melted at the lowest possible temperature and stirred thoroughly while cooling to insure homogeneity.

Procedure. 4. (*a*) Ten grams of the sample shall be dissolved in 100 cc. of carbon disulfide in a 150-cc. tall-form beaker. The solution shall be stirred thoroughly, allowed to stand for 15 minutes and approximately 90 per cent of the solution decanted. The sediment in the beaker shall then be treated in a similar manner three successive times with benzol at room temperature, using 90 cc. of benzol each time. Drying of the residue should be avoided until it is finally dried as described in Paragraph (*b*).

(*b*) The sediment and remaining benzol shall be washed into a 400-cc. tall-form beaker with water-white kerosine (having a flash point of 120° F.) at room temperature, and sufficient kerosine added to bring the total volume to 300 cc. This sediment and liquid shall then be agitated with an air-blast until thoroughly mixed, avoiding the formation of cyclonic currents. The mixture shall then be allowed to settle for 10 seconds and about 90 per cent of the solution decanted. This operation shall be repeated in a similar manner two additional times with 300 cc. of kerosine. After final decantation, the kerosine shall be removed from the remaining sediment by washing with carbon disulfide on to a tared filter paper, or a Gooch, or an alundum crucible and dried to constant weight at from 200 to 220° F. (95 to 105° C.).

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-8 on Bituminous Waterproofing and Roofing Materials, 441 Lexington Ave., New York City.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 515.

Percentage of Coarse Particles.

5. The percentage of coarse particles of mineral or other insoluble matter shall be calculated from the formula:

$$\text{Percentage of coarse particles} = \frac{\text{Weight of Final Sediment}}{\text{Original Weight of Sample}} \times 100$$

TENTATIVE METHODS OF ANALYSIS
OF
ROOFING FELT FOR FIBER COMPOSITION[1]

A.S.T.M. Designation: D 272 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1927; REVISED, 1929.

Scope. 1. These methods cover the examination of roofing felt to determine the percentage of various fibers contained therein.

SAMPLING

Sampling. 2. (*a*) From a shipment of rolls of felt to be tested representing a product of the same kind, class, and weight, a number of rolls shall be selected at random, equivalent to one-half the cube root of the total number of rolls in the lot, except that in lots of 1000 or less, 5 rolls shall be taken. From each roll a sample 1 in. in width across the width of the roll shall be taken from the first unharmed layer of the roll. The strips shall then be reduced in the laboratory to a sample of about 25 g. by cutting at least 100 small sections from different portions of the various strips taken for test.

(*b*) If the sample to be examined is an extracted felt obtained from the examination of a saturated felt or prepared roofing, the sample of 25 g. shall be obtained by cutting at least 100 small sections from different portions of the extracted felt obtained from the saturated felt or prepared roofing.

APPARATUS

Apparatus. 3. (*a*) *Microscope.*—The microscope shall be capable of giving a magnification of not less than 100 diameters and shall be of the compound type, provided with a mechanical stage, and substage condenser.

(*b*) *Graticule.*—The graticule or cross-line disk, for insertion into the eye-piece of the microscope, shall be ruled with two fine lines intersecting approximately at right angles.

(*c*) *Dropper.*—The dropper shall consist of a glass tube 20 cm. in length and 6 mm. in internal diameter fitted at one end with a rubber bulb and having the other end carefully smoothed but not constricted in a flame.

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[1] **Criticisms of these Tentative Methods are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-8 on Bituminous Waterproofing and Roofing Materials, 441 Lexington Ave., New York City.**

Stain. 4. *Herzberg Stain.*—The Herzberg stain used shall be prepared as follows:

Solution A.—Dissolve 50 g. of dry zinc chloride (fused sticks) in 25 cc. of distilled water, added to the zinc chloride bottle with a pipette. Stopper the bottle and shake well. There should be approximately 40 cc. of the solution.

The specific gravity of the solution determined at 28° C. shall be 1.8. If the specific gravity is not 1.8, add distilled water until the specific gravity is 1.8, and then pour the solution into a tall cylinder.

Solution B.—Wash the thermometer, hydrometer, and the original bottle containing the zinc chloride with a portion of 12.5 cc. of distilled water. Add this to Solution *A* in the tall cylinder.

Dissolve 5.25 g. of potassium iodide and 0.25 g. of iodine in the balance of the 12.5 cc. of distilled water, and add to Solution *A* in the tall cylinder.

Stir the solution in the tall cylinder well, and place in the dark. The following day, pipette off the clear portion into a black bottle, leaving 3 or 4 cc. of the solution above the sediment. Add a leaf of crystal iodine.

This stain should ordinarily be found to be satisfactory for at least two weeks. If for any reason the stain is unsatisfactory, it shall not be adjusted but new stain shall be prepared. On referee tests, no stain over seven days old shall be used.

PREPARATION OF SAMPLE

Preparation of Sample. 5. Ten grams of the sample shall be treated in a 400-cc. beaker with 200 cc. of water and heated to boiling. Stir the liquid thoroughly, preferably with a mechanical stirrer, until the sample is well pulped and the fibers well separated. The mass shall then be placed on a No. 100 (149 micron) sieve and washed thoroughly with water. The moist mass of paper retained on the sieve shall then be rolled into a ball and worked between the fingers to loosen the fibers thoroughly. Approximately one-fourth of this sample shall then be placed in a stoppered bottle and shaken thoroughly with 250 cc. of water until the fiber mass is thoroughly disintegrated and separated. Transfer three 25-cc. portions of this suspension to separate bottles and dilute each with water to 250 cc., so as to obtain suspensions of about 0.1 per cent pulp. These suspensions shall be thoroughly shaken before withdrawing samples for the microscope tests described in Section 6.

PROCEDURE

Preparation of Slide.

6. The fibers shall be transferred from the 0.1-per-cent pulp suspension to the microscopic slide as follows: Thoroughly mix the fibers and water by shaking thoroughly, quickly insert the dropper into the mixture 5 cm. (2 in.) below the surface, expel two bubbles of air from the dropper, then fill the tube to a distance of about 13 mm. ($\frac{1}{2}$ in.). Transfer the contents of the dropper to the slide, making four drops, completely emptying it. Repeat this procedure until the slide is uniformly covered with drops of the suspension, then place the slide in an air-bath until dry. Add stain to the slide by means of an ordinary dropper so as to uniformly cover the fibers with the stain. Allow to stand for 2 minutes, remove most of the excess stain with hard, clean-cut filter paper and press down a second slide or suitable cover glasses on the fibers. Remove the remaining excess of stain with absorbent paper.

Method of Observation.

7. Place the round-glass graticule on the diaphragm of the microscope. The point formed by the intersection of the two fine lines ruled on the graticule shall be used as the eye-piece reference point. Starting at one side of the slide about one-fourth of the way from the top, the slide shall be moved in a straight line across its entire width, by means of the mechanical stage. In moving thus through the field of view, each fiber or part of a fiber shall be counted which touches the eye-piece reference-point. Some of the fibers may be long and come under the point twice or more, but they shall be counted each time. If aggregations of fibers, such as occur in ground wood, are encountered, the number of single fibers in the aggregation shall be estimated and figured as if the individual fibers were completely separated. Another path across the slide shall be selected, about half way down from the top. The entire counting process shall be repeated and the results added to those obtained above. Repeat again over a path about three-fourths of the way down from the top and add the results to the total as before. In this manner not less than 300 fibers shall be counted on each slide using one or more up-and-down paths if necessary to obtain the required number. Each slide shall be calculated separately and the results for the different constituents compared with the average result. These shall agree with the average within the following permissible variations:

Cotton	$\pm \sqrt{\text{Average}}$
Chemical wood	$\pm (\sqrt{\text{Average}} + 1)$
Mechanical wood	$\pm (\sqrt{\text{Average}} + 2)$
Jute and Manila	$\pm (\sqrt{\text{Average}} + 3)$

If such agreement is not obtained, additional slides shall be made from new 0.1-per-cent suspensions and examined until three results are obtained which fall within the specified limits. The average of three such slides shall be reported as the result of the analysis.

Note.—To illustrate the application of the above tolerances, suppose the average of three slides for a given constituent is found to be 33 per cent. The square root of 33 is 5.7. Therefore, all individual results shall lie between 27.3 and 38.7 per cent if the constituent is cotton, and between 26.3 and 39.7 per cent if chemical wood, etc.

The fibers may be recognized (Note 3) by the colors developed by the stain, and by the surface appearance and markings on the fibers themselves.

Color	Fiber Composition
Red	Linen, cotton, bleached Manila hemp.
Blue	Chemically prepared fibers from wood, straw, and esparto.
Yellow (various shades to brown)	Ground wood, sawdust, jute, and Manila (Note 1).
Colorless	Wool (Note 2).

Notes

Note 1.—Ground wood and sawdust (mechanical wood) may be distinguished from jute and manila by the broken ends of the fibers, round, circular pits on the surface of the fibers as well as ray-like structure of portions of certain of the woods.

Note 2.—Wool fibers are also often variously colored from the dye to which the wool has been subjected prior to its use as a raw material for roofing felts and in such cases must be recognized by its regular cylindrical appearance, scale, and hook-like markings.

Note 3.—Proficiency and experience in recognizing the appearance and structure of the various fibers are essential for accurate testing. It is recommended that all operators carrying on the tests obtain *Technologic Paper No. 250*, of the Bureau of Standards, entitled "Pulp and Paper Fiber Composition Standards," which contains color plates of various fibers treated with the Herzberg stain. A study of these plates, together with preparation of slides from known materials, is necessary to familiarize the operator with the characteristics of the various fibers and thereby perfect his technique.

RESULTS

Calculation of Results.

8. The proportion of fibers found shall be reported in terms of percentage by counts of the total fiber composition and the following classes reported:

1. Cotton, linen, and bleached Manila hemp.................. --------
2. Chemical wood, straw, and esparto.................. --------
3. Mechanical wood.................. --------
4. Jute, and Manila.................. --------
5. Wool.................. --------
6. Unidentified fibers.................. --------

TENTATIVE METHODS OF TESTING INSULATING VARNISHES[1]

A.S.T.M. Designation: D 115 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1921; REVISED, 1922, 1923, 1924, 1925, 1926, 1928, 1929.

Scope.

1. These tests are intended for varnishes which are applied by brushing, dipping or spraying, and are primarily for the purpose of providing electrical insulation.

SPECIFIC GRAVITY

Specific Gravity.

2. The specific gravity shall be measured with a pycnometer, Westphal balance or with a hydrometer so graduated that the specific gravity can be determined to 0.001. The temperature of the varnish shall be not less than 18° C. (64.4° F.) nor more than 22° C. (71.6° F.) and corrected to 20° C. (68° F.) by applying a correction of 0.0007 per 1° C. (0.0004 per 1° F.).

VISCOSITY

Viscosity.

3. The viscosity shall be determined at 20° C. (68° F.) and the results shall be stated in terms of absolute viscosity — poise[2] or centipoise (centipoise = 0.01 poise).

NOTE 1.—When measurements are made by an indirect method, the instrument used must be standardized. Oils of standard viscosity for use in standardizing such instruments can be obtained from the U. S. Bureau of Standards.

NOTE 2.—A description of the MacMichael viscosimeter as remodeled and improved for varnish testing may be obtained from the secretary of Committee D-9 together with directions for its calibration in absolute units.

FLASH POINT

Procedure for Flash Point.

4. The flash point shall be determined in accordance with the Standard Method of Test for Flash Point of Volatile Flammable

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corporation, 230 Grove St., Bloomfield, N. J.

[2] The absolute viscosity of a material or its viscosity in absolute units (c.g.s., poises) has been defined as the force in dynes required to move, at a velocity of 1 cm. per second, one surface having an area of 1 sq. cm. past another parallel like surface 1 cm. away, overcoming the resistance to shear of the material filling the space between.

Liquids (A.S.T.M. Designation: D 56) of the American Society for Testing Materials.[1]

TIME OF DRYING

Test Specimen.

5. (*a*) Specimens for this test shall be pieces of thoroughly cleaned, smooth sheet copper or brass about 3 cm. (1.18 in.) wide and 20 cm. (7.88 in.) long and about 0.127 mm. (0.005 in.) thick.

(*b*) The specimen shall be dipped once in the varnish at a room temperature of approximately 20° C. (68° F.) and withdrawn slowly and uniformly (about 38 cm. (15 in.) per minute). The consistency of the varnish shall be first so adjusted by trial that, when dry as determined in accordance with Section 7, the average thickness of the film of varnish on each side of the metal shall be between 0.022 and 0.026 mm. (0.0009 and 0.001 in.) Care shall be taken before dipping the specimens that the varnish has stood in the dipping tank for a sufficient length of time to be free from air bubbles.

Procedure.

6. (*a*) Specimens of air drying varnish shall be dried in dust-free air at a room temperature of approximately 20° C. (68° F.).

(*b*) In the case of baking varnishes, six specimens shall be dipped and allowed to drain at a room temperature of approximately 20° C. (68° F.) until the varnish is set as indicated when the impression left on the surface by pressing lightly thereon with a finger will not become obliterated by further flow of the material. They are then to be dried in dust-free air in an oven at 105 to 110° C. (221 to 230° F.). At the end of the first 30 minutes, and again at the end of each 10-minute period thereafter, one specimen shall be taken from the oven and examined. In the case of slow-drying varnishes, this 10-minute period may be lengthened at the discretion of the operator.

NOTE.—The size of oven and the amount of ventilation have a considerable effect on the drying time of varnishes. For this reason the analytical type of electrically-heated oven should be used.

Time of Drying.

7. The varnish shall be considered dry when a piece of kraft paper 38 mm. (1.49 in.) in width and 152 mm. (6 in.) in length and approximately 0.063 mm. (0.0025 in.) in thickness does not adhere to the varnish when it is pressed on the surface of the varnish for one minute by a cylindrical 1-lb. weight, 1 in. in diameter. The kraft paper shall be applied in the vicinity of the center of the specimen and at right angles to it. The test shall be made at a temperature of approximately 20° C. (68° F.).

NOTE.—Certain types of varnishes dry with what is commonly known as a "tack"; but these types are rare. However, when testing them for drying time, it will be found that the kraft paper adheres to the varnish film and offers a certain amount of resistance to removal. On continued drying, the resistance to removal reaches constancy and is not changed by further drying. Therefore, the drying time is reported as the number of hours required to first reach constancy and the varnish should be reported as drying with a "tack."

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 300.

DIELECTRIC STRENGTH TEST[1]

Dielectric Strength Test Specimen.

8. (*a*) Specimens for the dielectric strength test shall be prepared by dipping pieces of kraft paper about 20 cm. (7.88 in.) square and about 0.076 mm. (0.003 in.) thick into the varnish which shall be at the consistency prescribed in Section 5 (*b*).

NOTE.—The paper used shall be that which is commercially known as No. 1 Sulfate Kraft. The surface of the paper shall be smooth, free from pimples or lumps and reasonably free from hairy fibers. The paper shall also be free from conducting particles, slime spots, creases, cuts, specks or other "paper defects."

(*b*) Each specimen shall be dipped twice, as specified in Section 5 (*b*), once in each direction, in order to give a more uniform thickness of coating. The specimen shall be dried after each dip in the same vertical position in which it was dipped.

(*c*) Specimens of air-drying varnish shall be dried in dust-free air after each dip at a room temperature of approximately 20° C. (68° F.) for a period six times as long as that determined in accordance with Section 7.

(*d*) Specimens of baking varnish shall be drained and then baked in dust-free air after each dip for a period three times as long as that determined in accordance with Section 7.

(*e*) The final thickness of the specimen shall be 0.152 mm. (0.006 in.) to within ± 15 per cent.

Procedure.

9. (*a*) The dielectric strength of the specimen shall be determined by applying alternating potential to two circular metal disks, 5.08 cm. (2.0 in.) in diameter and with edges rounded to a radius of 0.64 cm. (0.25 in.) which are placed in contact with the two sides of the specimen directly opposite each other and under a pressure of approximately 0.5 kg. (1.1 lb.). Starting at zero, the voltage shall be increased uniformly to breakdown at a rate of 0.5 kv. per second, except that if breakdown occurs at this rate in less than 40 seconds, the rate shall be decreased so that breakdown will occur in not less than 40 seconds. If the material fails at less than 5 kilovolts, the minimum time shall be reduced from 40 seconds to 20 seconds. Ten such punctures are to be made at various points selected at random on each specimen. In each test the thickness of

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[1] This test is relative only, but it gives more uniform results than those obtained with a copper base. See the Appendix for a procedure for determining the dielectric strength on a copper base.

the specimen is to be determined as close to the point of puncture as practicable.

NOTE.—When necessary, in order to get ten punctures, additional specimens should be tested.

(*b*) The frequency of the test potential shall be not greater than 100 cycles per second, and each part of the testing apparatus shall have a continuous rating of not less than 2 kva. (preferably larger). The wave form shall be a sine curve as defined, and the voltage shall be measured by methods approved by the American Institute of Electrical Engineers.[1]

(*c*) The voltage may be controlled by any approved method which does not distort the wave form beyond the limits prescribed above and which does not subdivide the voltage in steps greater than 500 volts. The apparatus shall comply with the Standards of the American Institute of Electrical Engineers.

Dielectric Strength.

10. The volts at puncture, the thickness of the specimen and the volts per mil of thickness shall be reported for each of the ten tests, together with the average, maximum and minimum volts per mil.

WATER ABSORPTION TEST

Procedure.

11. Specimens similar to those described in Section 8 shall be immersed in water at a room temperature of approximately 20° C. (68° F.) for a period of 24 hours. Upon removal from the water, the surface water shall be wiped off and dielectric strength tests made immediately as described in Section 9.

Dielectric Strength.

12. The volts at puncture, the thickness of the specimen and the volts per mil of thickness shall be reported for each of the ten tests, together with the average, maximum and minimum volts per mil.

HEAT ENDURANCE TEST

Test Specimens.

13. (*a*) Specimens shall be prepared by dipping pieces of thoroughly cleaned, smooth sheet copper or sheet brass about 20 cm. (7.88 in.) in length, 3 cm. (1.18 in.) in width and 0.127 mm. (0.005 in.) in thickness, into the varnish. The consistency of the varnish shall previously be adjusted by trial so that, when dry as determined in accordance with Section 7, the average thickness of the film of varnish on each side of the metal shall be between 0.022 and 0.026 mm. (0.0009 and 0.001 in.).

(*b*) Each specimen shall be dipped in the varnish at room temperature of approximately 20° C. (68° F.) and withdrawn slowly and uniformly (about 38 cm. (15 in.) per minute). The varnish shall be allowed to dry in the air (if an air-drying varnish) or baked in an oven at 105 to 110° C. (221 to 230° F.) (if a baking varnish) until dry as determined in accordance with Section 7. As soon as the first coat of varnish is dry, and the specimen is at room temperature, it shall be dipped again in the varnish in the reverse direction so as to give a uniform thickness of coating. The second coat of varnish shall be allowed to dry in the same manner as the first coat. When the second coat of varnish is dry, the specimen shall be measured. The thickness of varnish on each side of the metal shall be between 0.044 and 0.052 mm. (0.00173 and 0.00205 in.).

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[1] Standards of the American Institute of Electrical Engineers.

Procedure. 14. (*a*) The specimens shall be placed in a uniformly-heated oven, in which the temperature is maintained at 105 to 110° C. (221 to 230° F.). A specimen shall be removed at the end of the first 24 hours and every 24 hours thereafter.

(*b*) Each specimen, after heating, shall be tested at room temperature of approximately 20° C. (68° F.) by bending it through 180 deg. around a rod 0.32 cm. (0.125 in.) in diameter.

Report. 15. The number of hours of baking of the specimen which first showed cracking of the varnish film shall be reported, together with the make and type number of the oven used.

NOTE.—The size of oven and the amount of ventilation have a considerable effect on the heat endurance of varnish films. For this reason the analytical type of electrically-heated oven should be used.

OIL PROOF TEST

Oil Test Specimen. 16. (*a*) To test for the effect of oil, the specimens shall be prepared as prescribed in Section 13 (*a*).

(*b*) The specimens shall be dipped and dried as prescribed in Section 8 (*b*), (*c*) and (*d*).

Procedure. 17. The effect of oil on the varnish shall be determined by immersing the specimens in transformer oil at a temperature of 105 to 110° C. (221 to 230° F.) for 48 hours and noting the effect on the varnish as indicated, for example, by wiping with a piece of dry white cloth.

NOTE.—Incipient disintegration of the surface of the varnish may sometimes be detected by examining the oil for turbidity. If a specimen of the used oil filtered through filter paper can be distinguished from an unfiltered sample of the used oil, when the two samples in identical containers are held in front of a diffused light, the oil is turbid.

DRAINING TEST

(ALSO KNOWN AS "WORKING VISCOSITY" TEST)

Test Specimen. 18. A strip of bond paper 0.064 mm. (2.5 mils) in thickness, 10.2 cm. (4 in.) in width and 50.8 cm. (20 in.) in length, shall be immersed in the varnish at a room temperature of approximately 20° C. (68° F.) up to a line previously drawn across the paper a few inches from the top. The paper shall be withdrawn at a slow and uniform rate (about 38 cm. (15 in.) per minute), care being taken that the varnish is free from air bubbles. The specimen shall be permitted to drain thoroughly at room temperature while suspended in a vertical position. It shall then be dried or baked (according to the type of the varnish) until dry as determined in accordance with Section 7.

Measurements. 19. The thickness of the specimen in mils shall be measured at points 5.1 cm. (2 in.), 17.8 cm. (7 in.) and 30.5 cm. (12 in.), respectively, from the line to which the specimen was immersed.

Report 20. The thickness of each film in mils at the three points specified in Section 19 shall be recorded. The difference between the thickness at the upper point (5.1 cm.) and that at the lower point (30.5 cm.) shall be taken as a measure of the variation in the film thickness caused by draining.

EVAPORATION TEST

Procedure. 21. One hundred cubic centimeters of the varnish shall be placed in a flat-bottom crystallizing dish approximately 75 mm. (2.95 in.) in diameter and 45 mm. (1.77 in.) in height. It shall be heated to a temperature of 100° F. ± 2° F. (37.8° C. ± 1.1° C.) for a period of 7 hours, the sample being exposed to still air in the open room.

Evaporation. 22. The decrease in volume of the sample shall be taken as the evaporation, this decrease being determined by noting the amount of water or kerosine that must be added to fill the dish to the original level.

NOTE.—This test is relative only. That is, it is only suitable for comparing one varnish with another when the tests are made simultaneously under exactly the same conditions.

TEST FOR NON-VOLATILE MATTER BY WEIGHT

Procedure. 23. A portion of the sample shall be placed in a stoppered bottle or weighing pipette and weighed. About 1.5 g. of the sample shall be transferred to a weighed flat-bottom metal dish about 8 cm. (3.15 in.) in diameter, such as the cover of a friction-top tin can. The container shall again be weighed and the exact weight of the portion of the sample transferred to the weighed dish calculated by difference. The dish with its contents shall be heated for three hours in an oven maintained at 105 to 110° C. (221 to 230° F.). It shall then be weighed after cooling.

Non-Volatile Matter. 24. The ratio of the weight of the residue to the weight of the original sample expressed as a percentage shall be taken as the percentage of non-volatile matter by weight in the varnish.

TEST FOR VOLATILE MATTER BY VOLUME

Scope. 25. This test is intended to determine the volume percentage of volatile matter (solvent) in a varnish, and to afford a means of arriving at the volume composition of the varnish with respect to volatile (solvent) and non-volatile (base) constituents.

Procedure. 26. (*a*) About 100 cc. of the varnish shall be distilled in accordance with the Standard Method of Test for Distillation of Gasoline, Naphtha, Kerosine, and Similar Petroleum Products (A.S.T.M. Designation: D 86) of the American Society for Testing Materials.[1] The distillation shall be "qualitative" instead of "quantitative" as given in Section 9 of the Standard Method D 86; that is, it is not necessary to record the volume of distillate recovered, or the temperature of the initial boiling point or end point.

(*b*) The distillation shall be continued until a suitable end point indicates that all the volatile matter (solvent) has been distilled off.

NOTE.—In the distillation of varnishes the end point differs with the various types and compositions. In all cases, however, the rate of distillation slows down as the end point is approached; and, when the end point is reached, acrolein (formed in the decomposition of the varnish base) is evolved and may be detected by its characteristic odor.

In addition to the evolution of acrolein, the following phenomena are suitable indicators of end point:

(1) When the end point of the solvent is considerably lower than the initial boiling point of the base, the end point of the distillation is indicated by the temperature reaching a maximum and then starting to fall consistently.

(2) When the end point of the solvent and the initial boiling point of the base are too close, or overlap, the above temperature drop does not occur. The end point of the distillation is then indicated by a sudden foaming up of the residual base in the distillation flask; or, if the distillation has been accompanied by foaming, the end point is indicated by a breaking of surface tension with a consequent cessation of foaming.

Specific Gravity. 27. The specific gravity of the volatile matter (solvent) recovered by distillation shall be determined in accordance with the procedure described in Section 2.

Volatile Matter by Weight. 28. The difference between 100 per cent and the percentage of non-volatile matter determined in Sections 23 and 24 shall be calculated and recorded as the percentage of volatile matter by weight.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378.

Volatile Matter by Volume. 29. The percentage of volatile matter by volume shall be calculated from the formula:

$$x = \frac{AC}{B}$$

where

x = the percentage of volatile matter by volume;
A = the specific gravity of the original varnish, as determined in Section 2;
B = the specific gravity of the volatile matter (solvent) recovered by distillation, as determined in Section 27; and
C = the percentage of volatile matter by weight, as determined in Section 28.

Accuracy. 30. With proper care and attention to detail in making this test, differences occurring between different laboratories should not exceed 2 per cent for varnishes containing solvents which have end points not over 235° C. (455° F.), and should not exceed 4 per cent when the end point of the solvent is as high as 307.2° C. (585° F.).

DIELECTRIC STRENGTH OF VARNISH IN THE LIQUID STATE

Scope. 31. The purpose of the dielectric strength test of varnish in the liquid state is to insure that the varnish is free from moisture and foreign matter such as might come from unclean shipping containers.

Apparatus. 32. The apparatus shall be as described in Section 14 of the Standard Methods of Testing Molded Insulating Materials (A.S.T.M. Designation: D 48) of the American Society for Testing Materials.[1] The test cup for holding the sample of varnish shall be made of a material having a suitable dielectric strength. It must be insoluble in and unattacked by mineral oil and gasoline and non-absorbent so far as moisture, mineral oil and gasoline are concerned. The electrodes in the test cup between which the sample is tested shall be circular disks of polished brass or copper, 1 in. in diameter and having square edges. The electrodes shall be mounted in the test cup having their axes horizontal and coincident, with a gap of 0.1 in. between their adjacent faces, and with top of electrodes about 33 mm. ($1\frac{1}{4}$ in.) below the top of the cup.

Procedure. 33. (*a*) The electrodes and the test cup shall be wiped clean with dry calendered tissue paper or with a clean dry chamois skin, and thoroughly rinsed with a suitable solvent such as dry benzol or redistilled carbon tetrachloride. The electrodes and test cup shall then be rinsed with some of the varnish to be tested.

(*b*) The spacing of electrodes shall be checked with a standard round gage having a diameter of 0.100 in. and the electrodes then locked in position. Care shall be taken not to touch the electrodes with the gage or in any other manner after cleaning the electrodes and cup, so as to avoid any possible contamination.

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[1] 1929 Supplement to Book of A.S.T.M. Standards, p. 259.

(*c*) The temperature of the varnish when tested shall be the same as that of the room, which should be between 20 and 30° C. (68 and 86° F.).

(*d*) The sample of the varnish shall be shaken so that it will be thoroughly mixed before filling the test cup, the shaking shall be done gently to avoid the formation of bubbles.

(*e*) The cup shall be filled with varnish to a height of not less than 20 mm. (0.787 in.) above the top of the electrodes.

(*f*) The varnish shall be allowed to remain in the test cup until all air bubbles have disappeared.

(*g*) Voltage shall be applied and increased uniformly at the rate of approximately 3 kv. (r.m.s. value) per second until electrical breakdown occurs as indicated by a continuous discharge across the gap. (Occasional momentary discharges which do not result in a permanent arc may occur; these should be disregarded.)

(*h*) After the breakdown and before removing the varnish from the test cup, the electrode surfaces shall be rubbed thoroughly with dry calendered tissue paper wrapped around a knife blade to provide stiffness. The test cup shall then be emptied and immediately refilled with the next filling of varnish to be tested.

(*i*) Five fillings shall be tested in conformity with the above procedure and the last filling of the cup shall drain the sample container.

Variations in Results.

34. Differences as great as 15 per cent may occur between different laboratories in the results of this test. This is considered satisfactory in view of the purpose of the test.

Report.

35. The report shall include the following:

(*a*) The kilovolts (r.m.s. value) at each electrical breakdown;

(*b*) The average value of the 5 breakdowns in kilovolts; and

(*c*) The mean deviation from the average value expressed as a percentage of the average breakdown value.

APPENDIX

DIELECTRIC STRENGTH TESTS ON COPPER BASE

Where it is desired to make dielectric strength tests of solid films of varnish (as distinguished from the specimens prescribed in the methods, which are a combination of varnish and paper fibers), it is recommended that copper be used as the base as formerly required in the methods. The following are the directions for preparing and testing such specimens:

1. (*a*) Specimens are prepared by dipping pieces of thoroughly cleaned, smooth sheet copper or brass about 20 cm. (7.88 in.) square and about 0.127 mm. (0.005 in.) thick into the varnish which is at the consistency prescribed in Section 5 (*b*) of the methods.

(*b*) Each specimen is dipped twice, once in each direction, in order to give a more uniform thickness of coating. The specimen is dried after each dip in the same vertical position in which it was dipped.

(*c*) Specimens of air-drying varnish are dried in free air after each dip at a room temperature of approximately 20° C. (68° F.) for a period six times as long as that determined in accordance with Section 7 of the methods.

(*d*) Specimens of baking varnish are drained and then baked after each dip for a period three times as long as that determined in accordance with Section 7 of the methods.

(*e*) The final thickness of the film of varnish on each side of the specimen is between 0.044 mm. (0.0018 in.) and 0.052 mm. (0.002 in.).

2. (*a*) The dielectric strength of the two films of varnish is determined by applying alternating potential to two circular metal disks, 5.08 cm. (2.0 in.) in diameter and with edges rounded to a radius of 0.64 cm. (0.25 in.) which are placed in contact with the two sides of the specimen directly opposite each other and under a pressure of approximately 0.5 kg. (1.1 lb.). Starting at zero, the voltage is increased uniformly to breakdown at a rate of 0.5 kv. per second, except that if breakdown occurs at this rate in less than 40 seconds, the rate shall be decreased so that breakdown will not occur in less than 40 seconds. If the material fails at less than 5 kv., the minimum time shall be reduced from 40 seconds to 20 seconds. Ten such punctures are to be made at various points selected at random on each specimen. In each test the thickness of the films of varnish is to be determined as close to the point of puncture as practicable.

NOTE.—When necessary, in order to get ten punctures, additional specimens should be tested.

(*b*) The frequency of the test potential shall be not greater than 100 cycles per second, and each part of the testing apparatus shall have a continuous rating of not less than 2 kva. (preferably larger). The wave form shall be a sine curve as defined, and the voltage shall be measured by methods approved by the American Institute of Electrical Engineers.

(*c*) The voltage may be controlled by any approved method which does not distort the wave form beyond the limits prescribed above and which does not subdivide the voltage in steps greater than 500 volts. The apparatus shall comply with the Standards of the American Institute of Electrical Engineers.

3. The volts at puncture, the net thickness of insulation and the volts per mil of net thickness shall be reported for each of the ten tests together with the average maximum and minimum volts per mil.

TENTATIVE METHODS OF TESTING ELECTRICAL PORCELAIN[1]

A.S.T.M. Designation: D 116 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1921; REVISED, 1924, 1926, 1927, 1928, 1929.

Scope.

1. These methods are intended to apply to porcelain which is to be used for electrical insulating purposes. Specimens for purpose of tests shall be unglazed.

NOTE.—Tests on porcelain are made on unglazed specimens since it is desired to determine the strength of the porcelain structure only. Tests have indicated, however, that the glaze may have an effect on the mechanical strength. In some cases the values obtained are higher and in other cases lower than obtained on unglazed specimens. It is believed that this difference is due to the fact that the glaze may not "fit" the porcelain uniformly and therefore cause stresses to be set up within the porcelain body. Mechanical strength tests on unglazed and glazed specimens may therefore be of value as giving an indication of the "fit" of the glaze to the porcelain body.

TENSILE STRENGTH

Apparatus.

2. Any standard testing machine of suitable capacity may be used providing the error in the loading range does not exceed 1 per cent.

Test Specimens.

3. (*a*) The test specimens for this test shall be of the form and dimensions shown in Fig. 1.

(*b*) For wet-process porcelain, the test specimens shall be made from a column obtained by forcing the batch mixture through a die. Sections of the column, after thorough drying, shall be formed to the required shape with due allowance for shrinkage. During the firing, care shall be taken to maintain the axis perfectly straight.

(*c*) For cast porcelain, the specimens shall be cast in molds of calcined gypsum (plaster of Paris) having the required shape, due allowance being made for all shrinkages. None of the material except the fins shall be removed from the specimen.

(*d*) For dry-process porcelain, the specimens shall be formed by pressure into the required shape in metal molds with due allowance for all shrinkages.

Mounting of Specimens.

4. (*a*) Suitable grips for holding the specimen shall be self-aligning

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[1] **Criticisms of these Tentative Methods are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corp., 230 Grove St., Bloomfield, N. J.**

and shall grip the specimen over sufficient area and in a manner not to cause pinching near the minimum section nor local compression at the smaller ends of the metal grips. Grips designed for the purpose and found satisfactory are shown in Fig. 2. In principle they are arranged like gimbals or a universal joint used for maintaining a

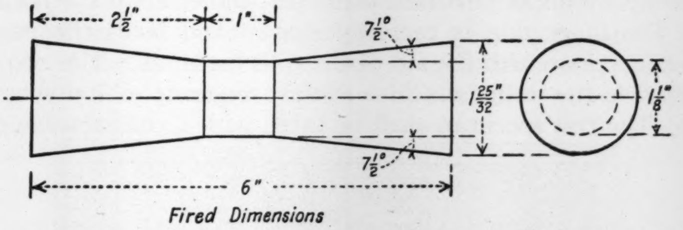
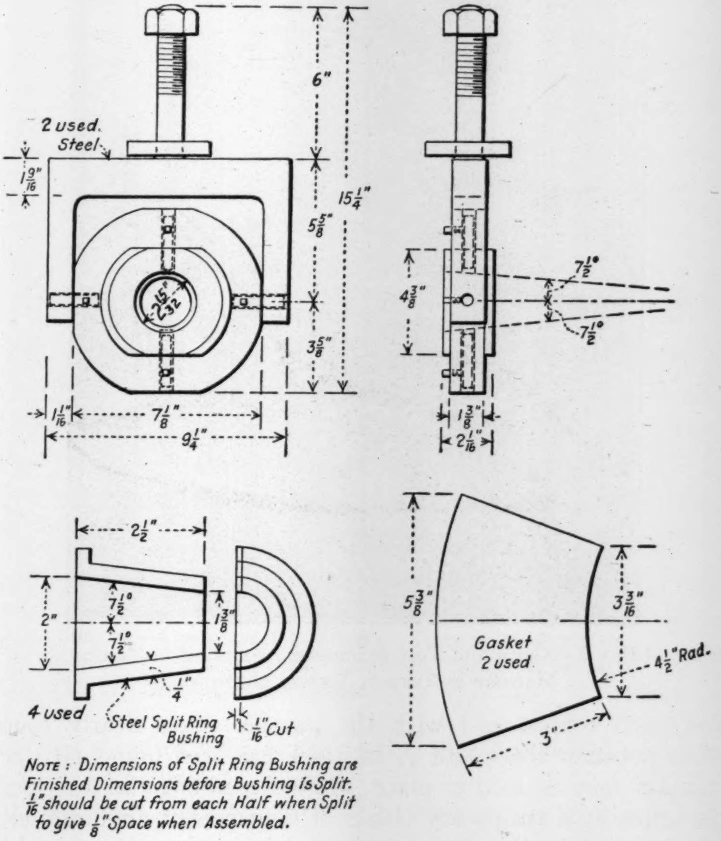

2½"
1"
7½°
1 25/32"
1⅛"
7½°
6"
Fired Dimensions

FIG. 1.—Test Specimen for Determining Tensile Strength of Porcelain.


2 used. Steel
1 9/16"
6"
15¼"
5⅝"
2 15/32"
3⅝"
1 1/16"
7⅛"
9¼"
4⅜"
7½°
7½°
1⅜"
2 1/16"
2½"
2"
7½°
7½°
1⅜"
¼"
4 used
Steel Split Ring Bushing
1/16" Cut
5⅜"
3 3/16"
Gasket 2 used
4½" Rad.
3"

NOTE: Dimensions of Split Ring Bushing are Finished Dimensions before Bushing is Split. 1/16" should be cut from each Half when Split to give ⅛" Space when Assembled.

FIG. 2.—Grips for Tension Testing of Porcelain.

mariner's compass in position. A yoke allows a ring to swing about a horizontal axis. A smaller ring is situated inside the first one but pivoted by means of pins in a plane perpendicular to the horizontal axis. The inner ring is conically shaped and holds the porcelain specimen in place with the aid of the split bushings. The two yokes are placed in the testing machine at right angles to each other.

(*b*) The test specimen shall be fitted with a compressible gasket around each conical end with the parallel edges nearly touching. Blotting paper or sheet lead $\frac{1}{32}$ in. thick has been found satisfactory. The gasket may be held in place, while assembling the test specimen in the grips, by a temporary clamp at the place of minimum section. After the specimen has been assembled in place ready for test, the temporary clamp shall be removed. The grips holding the test specimen in place in the testing machine are shown in Fig. 3. A disassembled view of the apparatus is shown in Fig. 4.

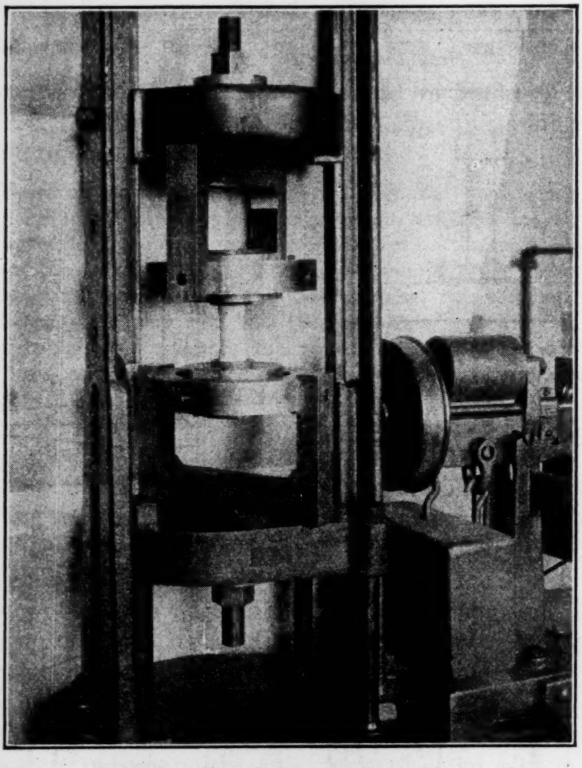


FIG. 3.—Grips and Test Specimens Assembled in Testing Machine in Tension Testing of Porcelain.

Procedure.

5. (*a*) Not less than five specimens shall be tested in the normal condition.

(*b*) The diameter of each specimen at the minimum section shall be measured with a micrometer graduated to 0.001 in. (0.025 mm.). The value of the diameter to be used in the calculation shall be the average of two measurements taken at right angles.

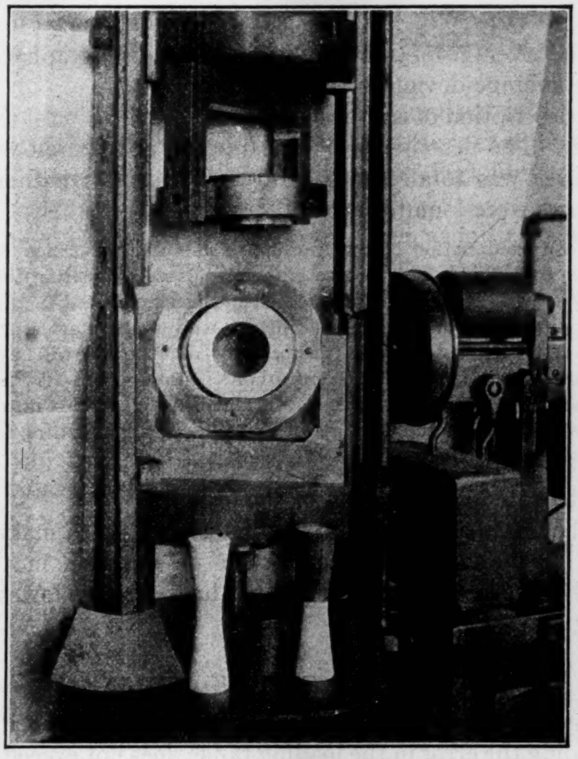


FIG. 4.—Apparatus for Tension Testing of Porcelain, Including Grips, Specimen, Split Ring and Blotting Paper Gasket.

(*c*) The speed of head of the testing machine shall be such that the load can be accurately weighed.

(*d*) The tests shall be made at a temperature of about 21° C. (70° F.).

(*e*) Results on specimens which do not break in the section of minimum cross-section shall be included, though the unit stress shall be calculated using the minimum cross-section. Any results whose deviation from the mean of the deviations is more than three times the mean of the deviations shall be discarded.

Report. 6. The report shall include the following:

(*a*) The breaking load of each specimen in pounds.

(*b*) The diameter of each specimen in inches at the place of break and at the minimum section.

(*c*) The tensile strength of each specimen in pounds per square inch.

(*d*) The average of the results given in Paragraph (*c*) and the percentage average deviation from the mean.

(*e*) A description of each fracture and the behavior of the material under load. The description of the fracture should tell whether the fractured area was totally or partially rough, and whether pin holes or other flaws were found.

NOTE.—An examination of the fracture of a normal specimen will show the entire area to consist of a very coarse granular surface, indicating that the entire area was subjected to tension and that the entire surface resisted it. In a specimen containing a pin hole or other flaw, the fracture will usually start near that flaw or pass through it. Part of the surface further away from the flaw will be granular, but the surface near the flaw will be much smoother. If the specimen is compressed at a narrow portion near one of the grips, the surface is again divided into two distinct areas, the area of tension and the area of shear, the latter radiating from the spot which was most under compression.

(*f*) The rate of application of the load.

(*g*) The name and rating of the machine used to make the tests.

(*h*) A curve sheet showing the tensile strength in pounds per square inch of each specimen, the first value being the lowest and each succeeding one the next higher.

COMPRESSIVE (CRUSHING) STRENGTH

Apparatus. 7. Any standard testing machine of suitable capacity may be used providing the error in the loading range does not exceed 1 per cent.

Test Specimens. 8. (*a*) The test specimens for this test shall be in the form of cylinders and shall be 1.125 in. (2.86 cm.) in length and 1.125 in. (2.86 cm.) in diameter.

(*b*) They shall be made as described in Section 3. The flat surfaces shall be made as smooth and parallel as possible before firing. After firing, the flat surfaces shall be ground smooth and parallel.

Procedure. 9. (*a*) Not less than five specimens shall be tested in the normal condition.

(*b*) A contact pad or cushion of blotting paper $\frac{1}{64}$ in. thick shall be placed between the upper and lower faces of the specimen and the self-aligning heads of the testing machine to equalize irregularities in the surfaces. Fresh cushions shall be used for each specimen.

(*c*) The diameter and length of each specimen shall be measured with a micrometer graduated to 0.001 in. (0.025 mm.). The value of the diameter to be used in the calculations shall be the average of two measurements taken at right angles.

(*d*) The speed of head of the testing machine shall be such that the load can be accurately weighed.

(*e*) The tests shall be made at a temperature of about 21° C. (70° F.).

Initial and Ultimate Failure.

10. Note shall be made of the load in pounds at initial failure but the value of the load in pounds at ultimate failure shall be determined and used in calculating the compressive (crushing) strength.

Report.

11. The report shall include the following:

(*a*) The load in pounds on each specimen at initial failure and the load in pounds at ultimate failure.

(*b*) The diameter and length of each specimen in inches.

(*c*) The compressive (crushing) strength of each specimen in pounds per square inch.

(*d*) The average of the results given in Paragraph (*c*) and the percentage average deviation from the mean.

(*e*) The behavior of the material under load.

(*f*) The rate of application of the load.

(*g*) The name and rating of the machine used to make the tests.

(*h*) A curve sheet showing the compressive strength in pounds per square inch of each specimen, the first value being the lowest and each succeeding one the next higher.

TRANSVERSE STRENGTH

Apparatus.

12. Any standard testing machine of suitable capacity may be used.

Test Specimens.

13. (*a*) The test specimens for the transverse strength test shall be in the form of cylinders and shall be 6 in. (15.2 cm.) in length and 1.125 in. (2.86 cm.) in diameter.

(*b*) They shall be made as described in Section 3.

Mounting of Specimens.

14. The specimen shall be supported on two steel wedge-shaped blocks with supporting edge rounded to 0.125 in. (3.175 mm.) radius. The supports shall be 5 in. (127 mm.) apart and the specimen shall be laid upon them with ½ in. (12.7 mm.) overlap at each end. The load shall be applied on top of the specimen at right angles to the specimen and midway between the supports by means of a wedge-shaped pressure piece (angle 45 deg.), the edge of which is rounded on a 0.125 in. (3.175 mm.) radius.

Method. 15. (*a*) Not less than five specimens shall be tested in the normal condition.

(*b*) The diameter of each specimen shall be measured with a micrometer graduated to 0.001 in. (0.025 mm.). The value of the diameter to be used in the calculations shall be the average of two measurements taken at right angles at the middle of the specimen.

(*c*) The load shall be applied at that constant rate of speed which will permit the beam to be kept well balanced at all loads.

(*d*) The tests shall be made at a temperature of about 21° C. (70° F.).

Modulus of Rupture. 16. The modulus of rupture shall be calculated for each specimen as follows:

$$M = \frac{8\,PL}{\pi\,d^3}$$

where M = modulus of rupture;
P = load in pounds at rupture;
L = distance between supports in inches;
d = diameter of specimen in inches;
π = 3.1416.

Report. 17. The report shall include the following:

(*a*) The breaking load of each specimen in pounds.

(*b*) The diameter and length of each specimen in inches.

(*c*) The modulus of rupture for each specimen as calculated in Section 16.

(*d*) The average of the results given in Paragraph (*a*) and the percentage average deviation from the mean.

(*e*) A description of each fracture and the behavior of the material under load.

(*f*) The rate of application of the load.

(*g*) The name and rating of the machine used to make the tests.

(*h*) A curve sheet showing the transverse strength (modulus of rupture) for each specimen, the first value being the lowest and each succeeding one the next higher.

RESISTANCE TO IMPACT

Resistance to Impact. 18. Resistance to impact shall be determined in accordance with the Tentative Methods of Testing Insulating Materials for Resistance to Impact (A.S.T.M. Designation: D 256 - 28 T) of the American Society for Testing Materials,[1] using the "Simple Beam Method."

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1021 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 625.

DIELECTRIC STRENGTH

Apparatus. 19. The apparatus shall be as described in Section 14 of the Standard Methods of Testing Molded Insulating Materials (A.S.T.M. Designation: D 48) of the American Society for Testing Materials.[1]

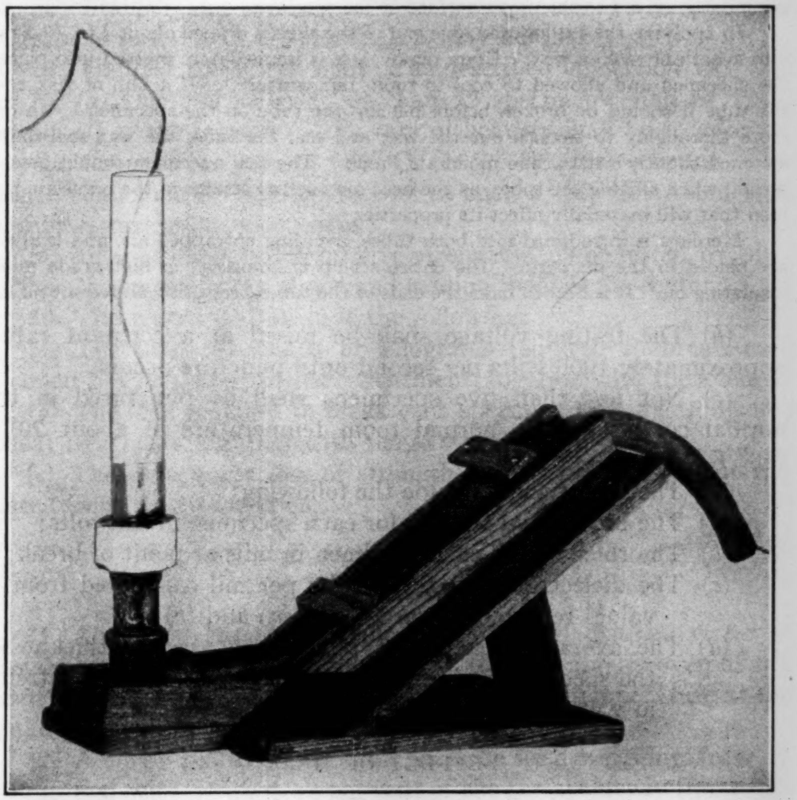

FIG. 5.—Suggested Means for Holding Porcelain Dielectric Strength Test Specimen.

Test Specimen. 20. The specimen shall be a disk approximately 2 in. in diameter, the flat sides being made plane and parallel. The thickness of the specimen shall be 0.250 in. (6.35 mm.), 0.4 in. (10.16 mm.), 0.75 in. (19.05 mm.), or 1.0 in. (25.4 mm.). The thickness shall be within ± 10 per cent of these values.

NOTE.—The specimen tested should be of a thickness comparable to that of the finished porcelain product.

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[1] 1929 Supplement to Book of A.S.T.M. Standards, p. 259.

Procedure. 21. (*a*) The specimen shall be tested between metallic electrodes 0.75 in. (19.05 mm.) in diameter, placed exactly opposite each other.

NOTE.—A suggested means for holding the specimen, using mercury electrodes, is shown in Fig. 5. This consists of a metal tube supported in a frame. The specimen is affixed to the metal tube using ordinary sealing wax, and a short glass tube is similarly affixed to the upper surface of the specimen.

In applying the sealing wax, one end of the tube is dipped about ⅜ in. (9.5 mm.) into a bath of molten wax. Upon removal, it is immediately pressed into place on the specimen and allowed to cool to room temperature. (If a film of wax covers the tube it should be broken before placing the tube on the specimen.) In order more thoroughly to smooth out the wax and seal the tube, the wax seal may be softened slightly with a fine moderate flame. The test specimen should never be heated when affixing the tubes, as the heat may set up strains in the porcelain specimen that will materially affect its properties.

Mercury is introduced into both tubes, avoiding entrapped air, and lead wires are placed in the mercury. The entire set-up is immersed in high-grade mineral insulating oil. It is best to have the ends of the tubes projecting above the oil level.

(*b*) The testing voltage shall be raised at a constant rate of approximately 1000 volts per second until puncture occurs.

(*c*) Not less than five specimens shall be punctured in their normal condition at a normal room temperature of about 20° C. (68° F.).

Report. 22. The report shall include the following:

(*a*) The breakdown voltage for each specimen in kilovolts;

(*b*) The thickness of each specimen in mils at point of break;

(*c*) The dielectric strength in volts per mil calculated from the values reported in Paragraphs (*a*) and (*b*);

(*d*) The average breakdown voltage, the average thickness of the specimen at break, and the average dielectric strength in volts per mil for the specimens tested.

EFFECT OF HEAT

(*A*) *Resistance to Thermal Change*

Apparatus. 23. The apparatus shall consist of a hot water bath maintained at a temperature of 100° C. (212° F.) and an ice water bath maintained at 0° C. (32° F.).

Specimens. 24. The test specimens shall be as described in Section 13.

Procedure. 25. (*a*) The test specimen shall be immersed in the ice water bath for ten minutes and then transferred as quickly as possible to the hot water bath, and allowed to remain there for ten minutes. The specimen shall be transferred back to the cold water and the cycles continued until the specimen breaks.

(*b*) Not less than five specimens shall be tested.

26. Report the number of cycles necessary to cause fracture of each test specimen. **Report.**

(*B*) *Effect on Mechanical Strength*[1]

27. A furnace in which a temperature of 900° C. (1652° F.) can be obtained and any suitable testing machine for determining the transverse strength of small beams may be used. **Apparatus.**

28. The test specimens shall be as described in Section 13. **Specimens.**

29. (*a*) One-half of not less than 12 specimens shall be taken and placed in the furnace. The rate of heating shall be so adjusted that the temperature reaches 900° C. (1652° F.) in two hours. The furnace shall then be allowed to cool at such a rate that room temperature is reached in four hours. **Method.**

(*b*) All specimens for transverse strength shall be tested by placing them on supports 5 in. apart and loading them at the center.

30. The report shall include the following: **Report.**

(*a*) The load in pounds or kilograms required to break each specimen not subjected to heat treatment, together with the average.

(*b*) The load required to break each specimen that was subjected to heat treatment, together with the average.

(*c*) The percentage loss of strength due to heat treatment calculated from the two averages.

POROSITY

(*A*) *Water Absorption*

31. Any good chemical balance, a beaker of distilled water at normal room temperature of about 20° C. (68° F.) and an oven of any standard make capable of maintaining a uniform temperature at the desired point within ±5° C. shall be provided. **Apparatus.**

32. A single piece of porcelain shall be used weighing from 30 to 50 g. and with at least 50 per cent of the surface newly fractured. **Specimens.**

33. The specimen shall be dried for 24 hours at 120° C. (248° F.), cooled in a desiccator and weighed. The specimen shall then be totally submerged in the distilled water at room temperature (about 20° C.) and allowed to remain submerged for 100 hours. The water shall be boiled for approximately one hour during the first, twenty-fifth, forty-ninth and seventy-third hours. The specimen shall be removed at the end of the 100-hour period, the surface moisture carefully dried off with a clean, dry cloth and the specimen weighed. **Procedure.**

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[1] This method is particularly suited to testing porcelain for spark plugs and heating devices, but may be used for testing other porcelains.

Report. 34. The report shall include the following:

(*a*) The original weight of the specimen;

(*b*) The dry weight of the specimen;

(*c*) The weight of the specimen after immersion for 100 hours;

(*d*) The percentage of moisture content in each specimen as received and the percentage of moisture absorbed during 100 hours, taking the dry weight as 100 per cent, and the average where more than one specimen is tested.

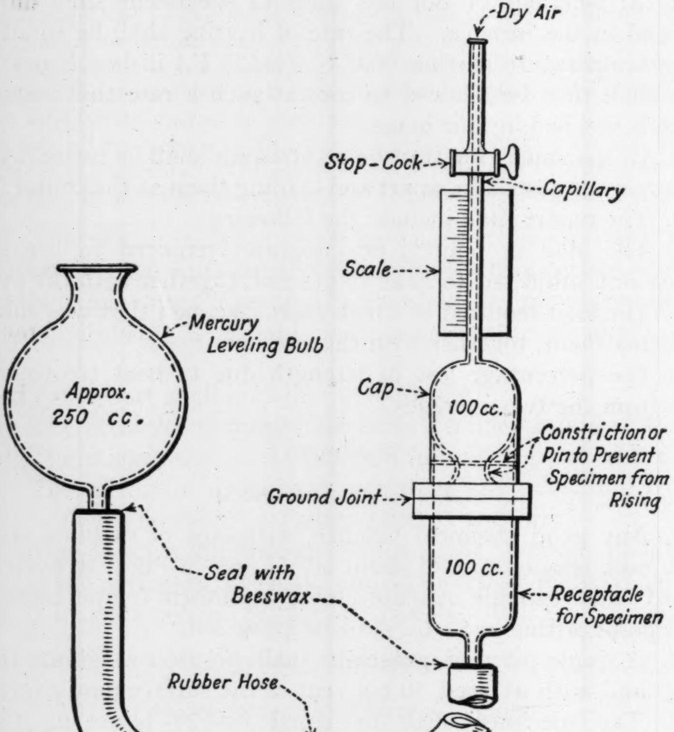
Dry Air
Stop-Cock
Capillary
Scale
Mercury Leveling Bulb
Approx. 250 cc.
Cap
100 cc.
Constriction or Pin to Prevent Specimen from Rising
Ground Joint
Seal with Beeswax
100 cc.
Receptacle for Specimen
Rubber Hose

FIG. 6.—Diagrammatic Sketch of McLeod Porosimeter.

(*B*) *Pore Volume*

Pore Volume. 35. The pore volume of porcelain shall be determined by measuring (at atmospheric pressure) the volume of air contained in a sample of porcelain of known volume.

Apparatus. 36. Any suitable apparatus based on the laws of gas expansion which will accomplish the measurement called for in Section **35** may be used.

The McLeod gage type of porosimeter is especially adaptable to this determination. This apparatus consists of a receptacle and cap fitted together by a ground air-tight joint. The cap is surmounted by a calibrated capillary tube and stop-cock. The specimen is placed in the receptacle and prevented from rising into the cap by means of a constriction or pin. The receptacle is connected by a glass or metal pipe at the bottom to a heavy rubber hose which in turn is connected to a glass leveling bulb. The total volume of the specimen receptacle and cap should be approximately 200 cc. Figure 6 shows a diagrammatic sketch of a McLeod gage-type porosimeter.

NOTE.—Suitable porosimeters of the McLeod gage type are: (1) glass apparatus of Washburn and Bunting;[1] (2) metal apparatus of Navias.[2]

Volume and Length of Capillary.—For porcelain of low-pore volume it is necessary to use a capillary of small diameter to read the volume of accumulated air accurately. Thus, for porcelain up to 1 per cent pore volume the effective volume of the capillary must be at least 0.5 cc. (for a specimen of 50 cc. volume). For porcelain having a higher pore volume than 1 per cent, either a longer capillary or a capillary of larger diameter is required.

Atmospheric Conditions.—It is essential that the determination be made using dry air. This may be provided by any suitable means.

Test Specimen.

37. The test specimen shall consist of two or more pieces of porcelain having a total volume of not less than 50 cc. At least 50 per cent of the surface of the parts used shall be newly fractured.

Procedure.

38. (*a*) The following procedure is based on the use of a McLeod gage type of porosimeter:

(*b*) The fractured pieces of porcelain shall be placed in the receptacle, the ground joint greased, and the cap secured in position so that the apparatus is air-tight.

(*c*) Before making determinations, any moisture entrapped on the inner surfaces of the porosimeter or which may be on the test specimen shall be removed. To do this, the leveling bulb shall be raised until the mercury in the capillary is above the stop-cock. The stop-cock shall then be closed and the leveling bulb lowered so that the test specimen is subjected to a vacuum for at least one minute. Any moisture inside the porosimeter then vaporizes and by again raising the leveling bulb the gas is collected in the capillary and shall be finally expelled by opening the stop-cock.

(*d*) Immediately after removing the moisture the leveling bulb shall be lowered, exposing the test specimen to the air for at least one minute. The leveling bulb shall again be raised until the mercury in the capillary is above the stop-cock. The stop-cock shall then be closed and the leveling bulb lowered so as to expose all the specimen to the vacuum for at least one minute. The air contained in the porcelain then expands into the evacuated space around and above the porcelain. The mercury bulb shall then be raised again and the air collected in the capillary tube. When the mercury surface in the leveling bulb is on a level with the mercury meniscus in the capillary the accumulated air in the capillary is at atmospheric pressure and its volume, v, shall be read. This shall be considered to be the pore volume.

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[1] Washburn and Bunting, *Journal*, Am. Ceramic Soc., Vol 5, pp. 528–535 (1922).

[2] Navias, *Journal*, Am. Ceramic Soc., Vol. 8, pp 816–821 (1925).

(*e*) Several determinations of the pore volume should immediately be made as described in Paragraph (*d*). The values of pore volume thus obtained should be practically equal, and their average may be taken as the pore volume of the specimen, v. Lack of agreement among these values may be traced to leaks or moisture in the apparatus.

NOTE.—To test for leaks in the apparatus: After taking a reading, expel all gas from the apparatus. Close the stop-cock. Raise and lower the leveling bulb several times. The level of the mercury in the capillary should rise to the stop-cock when the leveling bulb is raised.

(*f*) The total volume V, of the pieces of each specimen shall be obtained by any suitable method, measuring to the nearest 0.2 cc.

(*g*) Not less than five specimens shall be tested.

Percentage of Pore Volume.

39. The percentage of pore volume shall be calculated as the volume of gas contained in the total volume of porcelain:

$$\text{Percentage of pore volume} = \frac{v \times 100}{V}$$

where V = total volume of test specimen as determined in Section 38 (*f*); and
v = the pore volume as determined in Sections 38 (*d*) and (*e*).

Report

40. The report shall include the following:

(*a*) The percentage of pore volume of each specimen, the average of these values, and the percentage average deviation from the mean;
(*b*) The total volume of each test specimen;
(*c*) The name and type of the apparatus used;
(*d*) The total volume of the specimen receptacle.

TENTATIVE METHODS OF TESTING CABLE SPLICING AND POTHEAD COMPOUNDS[1]

A.S.T.M. Designation: D 176 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1923; REVISED, 1924, 1925, 1929.

Scope. 1. These tests are intended to cover compounds used in cable splices and potheads.

PHYSICAL TESTS

Physical Tests. 2. Each of the following tests shall be made in accordance with the method of test applicable, of the American Society for Testing Materials, as indicated:

(*a*) *Melting Point:* Tentative Method of Test for Melting Point of Petrolatum (A.S.T.M. Designation: D 127 - 28 T).[2]

(*b*) *Softening Point*, for compounds having no definite melting point: Standard Method of Test for Softening Point of Bituminous Materials (Ring-and-Ball Method) (A.S.T.M. Designation: D 36),[3] or

Standard Method of Test for Softening Point of Tar Products (Cube-in-Water Method) (A.S.T.M. Designation: D 61).[4]

The method used should be indicated in the report.

(*c*) *Flash and Fire Points:* Standard Method of Test for Flash and Fire Points by Means of Open Cup (A.S.T.M. Designation: D 92).[5]

(*d*) *Evaporation:* Standard Method of Test for Loss on Heating of Oil and Asphaltic Compounds (A.S.T.M. Designation: D 6).[6]

(*e*) *Viscosity*, Temperature range from melting point to 150° C.: Saybolt Furol, Standard Methods of Test for Viscosity of Petroleum Products and Lubricants (A.S.T.M. Designation: D 88).[7]

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corp., 230 Grove St., Bloomfield, N. J.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 931 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 395.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 496.

[4] *Ibid.*, p. 501. [5] *Ibid.*, p. 404. [6] *Ibid.*, p. 489. [7] *Ibid.*, p. 427.

(*f*) *Penetration Test*, Temperature range from melting or softening point to −25° C.: Standard Method of Test for Penetration of Bituminous Materials (A.S.T.M. Designation: D 5).[1]

Brittleness. 3. To determine the brittleness of the material, the compound shall be spread on a piece of sheet metal in a layer $\frac{1}{16}$ in. in thickness. It shall then be submerged in water having a temperature at least 20° F. above the expected breaking point. It shall then be cooled 5° F. and held at this temperature for 5 minutes. The cooling shall then be continued in increments of 5° F. At each temperature interval the compounds shall be tested with the blade of a knife, inserting the point with the blade as nearly parallel with the sheet metal as is practicable, and pulling the compound from the sheet metal as rapidly as possible by rotating the blade about its back as an axis. The temperature at which the compound no longer stretches but snaps, shall be considered the breaking point.

DIELECTRIC STRENGTH TEST

Dielectric Strength. 4. (*a*) This test is intended to determine the dielectric strength of cable splicing and pothead compounds under voltage stresses of short duration. It is of value as a comparative test but does not indicate the permanent dielectric strength of these compounds.

(*b*) The dielectric strength of this class of material varies with the temperature. It is, therefore, recommended that a sufficient number of tests be made at different temperatures to establish the momentary dielectric strength - temperature curve from 0 to 100° C.

Sample. 5. A representative sample shall be taken from the original package, melted and poured directly into the testing container. Care should be exercised in melting and pouring the compound not to overheat it nor to entrap air. The electrodes shall be heated to the approximate temperature of the compound before filling the container.

Electrodes. 6. (*a*) The testing container, after filling, shall be placed in a suitable constant-temperature air bath or oil bath and sufficient time allowed to elapse to bring the entire mass to a uniform temperature. The temperature shall be determined by a thermocouple attached to one of the metal electrode ends or by a mercury thermometer placed vertically touching an electrode and approximately $\frac{1}{2}$ in. (1.25 cm.) from the gap between electrodes.

(*b*) The test shall be made between polished hemispherical (Note 1) brass or copper electrodes $\frac{1}{2}$ in. in diameter separated by a gap of 0.1 in. (Note 2).

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 493.

NOTE 1.—A convenient form of apparatus for holding the electrodes and compound is described in the Appendix. It is recognized that when liquid materials are being tested, this method is inconsistent with the Standard Methods of Testing Electrical Insulating Oils (A.S.T.M. Designation: D 117) of the American Society for Testing Materials.[1] However, since spherical electrodes are considered preferable for solid and semi-solid materials, the advantage of using spherical electrodes for all splicing compounds, whether liquid or solid, so that direct comparison can be made, is sufficiently great to justify the inconsistency with Methods D 117.

NOTE 2.—In the case of materials which cannot be broken down with the available voltage, the gap may be reduced to 0.05 in. but results will not be comparable directly with those obtained with the 0.1-in. gap.

Testing Transformer Voltage Control and Measurement.

7. (*a*) The testing transformer used, methods of voltage control and measurement shall be as outlined in Section 2 of the Tentative Methods of Testing Sheet and Tape Insulating Materials for Dielectric Strength (A.S.T.M. Designation: D 149 – 27 T) of the American Society for Testing Materials.[2]

(*b*) The actual gap at the test temperature shall be determined by direct measurement or by measurement at some other temperature and computation of changes due to expansion or contraction.

Number of Specimens.

8. Five specimens at a given temperature shall be tested and the average value taken as the momentary dielectric strength of the compound at that temperature.

Report.

9. The report shall include the following:

(*a*) The momentary dielectric strength – temperature curve;

(*b*) The individual values of the puncturing voltage and the gap length at the various temperatures.

COEFFICIENT OF EXPANSION

Apparatus.

10. Calibrated flasks of Pyrex or quartz glass holding approximately 250 cc. to the zero mark, having necks 1 cm. in internal diameter and graduated for 25 cc. in 0.1-cc. divisions, total capacity approximately 275 cc., shall be used.

NOTE.—If it is necessary to use a small sample, then a Cassia flask holding 100 cc., with neck graduated for 10 cc. in 0.1-cc. divisions, may be used.

11. The cylindrical oil bath for heating the sample shall be approximately 10 in. (25.4 cm.) in inside diameter and 20 in. (50.8 cm.) in inside depth with a false bottom 1 in. from the bottom and shall have provision for circulating the oil.

NOTE.—This bath may be made as follows: A shell about 10 in. (25.4 cm.) in inside diameter and 20 in. (50.8 cm.) in inside depth is electrically heated by winding the shell with resistance wire and covering with five layers of asbestos paper. A motor-driven paddle at the bottom will give effective oil circulation.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 796.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 995 (1927); also 1929 Book of A.S.T.M. Tentative Standards, p. 577.

12. A lead collar to be hung on the flask during test to prevent the oil currents of the bath from moving the flask.

Calibration. 13. The capacity of the flask at the zero point and several points on the scale shall be determined by filling the flask with distilled water at a known temperature and weighing.

Procedure. 14. The flask shall first be warmed slightly, then partly filled with melted compound and placed in the bath which shall then be brought to the highest temperature of the range over which the test is to extend. The flask shall then be filled to within the last cubic centimeter marked on the neck. The bath shall be held at this temperature for not less than 30 minutes (principally to remove air bubbles) and the whole shall then be slowly cooled to room temperature (10 to 12 hours). Before starting the test, the flasks shall be examined for the presence of cavities or irregular contraction of the compound. Some compounds, after cooling below the liquid state, tend to stick to the sides of the neck of the flask. In that case it is necessary to gradually warm the neck and flow the compound to meet the rest, after which the flask is placed in the bath for an hour or so to insure equalizing the temperature.

With the compound satisfactorily placed in the flasks at the lowest temperature, the height of the column in the neck shall be read and the bath then slowly heated. Readings shall be taken at 5° C. intervals, holding the bath as constant as possible at each point until no more expansion occurs at that point, the procedure being repeated for each point until maximum temperature is reached.

Precautions. 15. During the test, temperature readings shall be taken at top and bottom of the bath to detect any variation.

Until the compound is completely liquefied, intervals between readings should be three to four hours, especially between 35 and 55° C.

After becoming liquefied, the time necessary for obtaining a reading may be reduced to about 30 minutes.

Report. 16. (*a*) After securing the readings over the temperature range desired, a curve shall be plotted from the temperature and flask readings from which the coefficient of expansion shall be calculated from the formula:

$$\text{Coefficient of expansion of the compound} = \frac{V_1 - V}{(T_1 - T)\,V} + C$$

where V = original volume;
V_1 = volume at higher temperature;
T = original temperature;
T_1 = higher temperature;
C = constant = coefficient of expansion of glass container.

(*b*) The coefficient shall be calculated for three ranges as follows:

(*1*) From the minimum temperature at which the measurement was made to 10° C. below the melting point. This is intended to give the average coefficient for the solid condition.

(*2*) From 5° C. above the melting point to 100° C. This is intended to give the average coefficient for the liquid condition.

(*3*) From the minimum temperature at which a measurement was made to 100° C.

In reporting the coefficient of expansion the corresponding temperature range shall be indicated in each case.

APPENDIX

Because of the great difficulty experienced in removing most cable splicing and pothead compounds from the container and from the electrode an arrangement is desirable which is sufficiently inexpensive to permit of it being discarded fully or in part after the test. Two devices that have proved satisfactory are illustrated in Figs. 1 and 2.

Figure 1 shows the simplest device. It consists of a box about 2 in. square in cross-section and 2 in. in length inside of the wooden ends. The sides and bottom are made from a single piece of press board and are attached to wooden blocks which form the ends. Holes drilled through the wooden blocks receive the electrodes which are turned from ½ in. diameter brass rod. To facilitate adjustment of the gap length, a gage is arranged to slip over the ends of the electrode and so regulate the gap to the desired value.

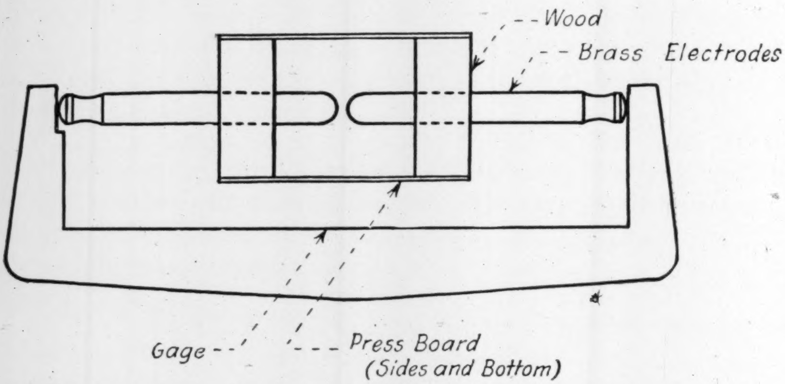

FIG. 1.—Container, Showing Electrodes in Place for Dielectric Strength Test.

Figure 2 shows a more elaborate type of testing device consisting of a framework made from laminated phenol fiber about 8 in. (20 cm.) in length and 2¼ in. (5.7 cm.) square with brass bushings centrally inserted in each end member to hold the electrode rods. A box of heavy paper or pasteboard is arranged to fit loosely inside the framework. The electrodes, which are separable by means of screw joints, are inserted through small holes in the ends of the paper box and clamped to make an oil-tight joint. The proper electrode spacing may be obtained by means of an adjusting screw on the right-hand end. Changes in the electrode spacing with temperature can be reduced greatly (to less than 0.001 in. in a change of temperature of 75° C.) by the indicated electrode design. Phenol fiber of suitable coefficient of expansion is used for supporting the brass hemispherical electrode tips and electrical connection is made by a copper wire through the center of the fiber rod. The volume of the container may be reduced to accommodate small samples by the insertion of wedges of carefully dried wood into the corners of the paper box.

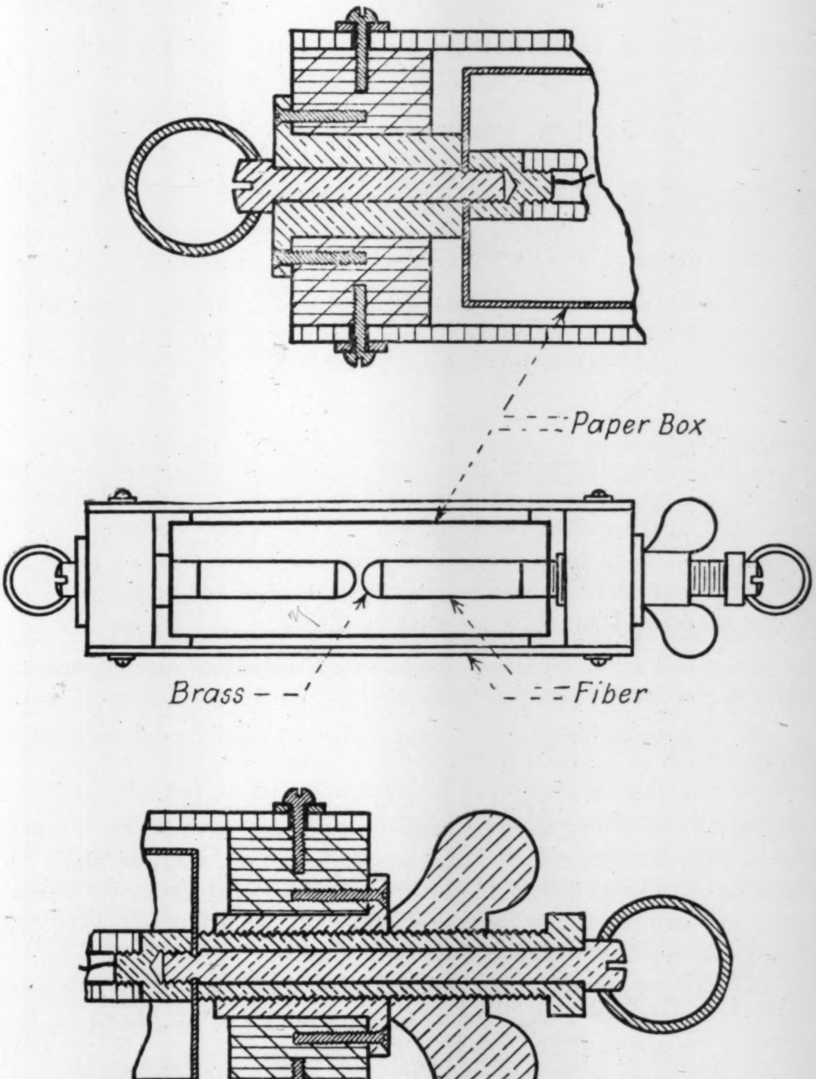
Paper Box
Brass
Fiber

FIG. 2.—Container, Showing Electrodes in Place for Dielectric Strength Test.

TENTATIVE METHODS OF TESTING UNTREATED INSULATING PAPER[1]

A.S.T.M. Designation: D 202 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1924; REVISED, 1925, 1926, 1927, 1928, 1929.

Scope. 1. These methods apply to untreated paper which is to be used as an electrical insulator or as a constituent of a composite material used for electrical insulating purposes.

SAMPLING

Sampling. 2. (*a*) From shipments consisting of rolls, a sample of at least 1 sq. yd. in area, cut across the entire width of the roll, shall be taken from every tenth roll in the shipment. From other shipments such as sheets or pads of tape, samples of equivalent area shall be taken in such a manner as to be equally representative of the shipment. In no case shall less than three samples be taken.

NOTE.—It is recommended that several turns of paper from each roll sampled be torn off and discarded before the samples are taken.

(*b*) The tests for physical properties shall be made upon each sample.

(*c*) The tests for acidity, moisture content, size,[2] ash and for identification of fibers[2] shall be made in duplicate upon portions taken from a composite sample. This composite sample shall be made up of a sufficient number of small pieces, each of approximately 6.5 sq.cm. (1 sq. in.) in area taken in nearly equal amounts from each of the samples taken in accordance with Paragraph (*a*).

(*d*) The required number of samples shall be taken at equal intervals across the sheet, the two end samples being taken at the edges of the sheet after removing any damaged paper. When it is not possible to secure the required number of specimens in this manner in going once across the sheet, the selection across the sheet shall be repeated as many times as necessary until the required number of specimens is secured.

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corp., 230 Grove St., Bloomfield, N. J.

[2] The tests for size, identification of fibers, and folding endurance do not appear in these methods but will be included as soon as the tests are developed by the committee.

CONDITIONING SAMPLES

Conditioning. 3. Samples shall be conditioned in air maintained at a relative humidity between 60 and 65 per cent as measured with a sling psychrometer or its equivalent. The temperature of the air shall be maintained as constant as possible at some temperature between the limits of 20 and 30° C. (68 and 86° F.). The samples should remain in the conditioned air for not less than 4 hours prior to the tests and should be supported so as to allow a free circulation around each sample. The following physical tests shall be made in the conditioned air: tensile breaking strength, tearing strength, bursting strength, folding endurance,[1] air resistance, dielectric strength and thickness.

MOISTURE CONTENT

Apparatus. 4. A weighing bottle, evaporating dish, thermometer, constant-temperature oven, chemical balance and desiccator are necessary for the test. The weighing bottle should be of convenient size, about 65 mm. (2.56 in.) in height and 45 mm. (1.77 in.) in diameter with a wide mouth provided with a ground-glass stopper. The chemical balance should be sensitive to 0.1 mg.

Specimen. 5. The moisture content figure is used to calculate the percentage of acidity, size, and ash of the paper to the bone-dry basis. It shall be determined on 2 to 5-g. samples selected in accordance with Section 2 (*c*).

If the moisture content of the paper as received at the purchaser's works is desired or at any other stated time, it shall be made on the sample taken at the definitely stated time by cutting small pieces of approximately 6.5 sq. cm. (1 sq. in.) in area from the required number of rolls or pads of tape in accordance with Section 2 (*a*) and immediately placed into an air-tight container.

NOTE.—Since paper adjusts itself, as regards moisture content, to the humidity of the surrounding atmosphere in a very short time (2 or 3 minutes), special care must be exercised to transfer rapidly the sample from the roll or bundle to the container and from the container to the weighing bottle.

Procedure. 6. The sample before drying shall be weighed in the tared bottle with the stopper in place. The bottle shall then be placed in the oven at 100 to 105° C. (212 to 221° F.), the stopper removed and laid alongside of the bottle and the contents transferred to the drying dish. After one hour, while still in the oven, the sample shall be replaced in the weighing bottle, and the bottle stoppered and transferred to the desiccator. The stopper should be removed while the bottle cools. When the specimen and the bottle have cooled to room temperature, the stopper shall be replaced and the bottle with its contents weighed. This process shall be repeated at intervals of one hour until the difference in weight between two successive weighings is not more than 0.2 per cent of the weight of the specimen.

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[1] The tests for size, identification of fibers, and folding endurance do not appear in these methods but will be included as soon as the tests are developed by the committee.

NOTE.—The weighing bottle or sample should not be touched with the fingers during this test.

Report. 7. The moisture content shall be expressed:

(*a*) as a percentage of the weight of the dry sample, and

(*b*) as a percentage of the weight of the undried sample.

THICKNESS

Apparatus. 8. A micrometer of the spring actuated, dial type shall be used. The plunger shall be capable of being raised by the application of an upward pressure to it. The plunger surface shall be circular in shape and 12.7 mm. (0.50 in.) in diameter. The anvil surface shall be plane and circular in shape, the diameter of which shall be not less than 12.7 mm. (0.50 in.). It shall be centered with respect to the plunger surface.

In addition to these requirements, the instrument shall conform to the following:

(*a*) The pressure applied to the plunger necessary to move the pointer from zero toward a positive reading shall not be greater than 1135 g. (40 oz.).

(*b*) The pressure applied to the plunger necessary to just prevent movement of the pointer from zero toward a lower reading shall not be less than 455 g. (16 oz.).

(*c*) The diameter of the dial shall be approximately 15 cm. (6 in.) and shall be graduated preferably in divisions indicating a thickness of 0.0127 mm. (0.0005 in.) and in no case greater than 0.0254 mm. (0.001 in.). Graduations indicating a thickness of 0.0254 mm. (0.001 in.) shall be at least 3 mm. (0.12 in.) apart.

(*d*) Measurements made on standard steel thickness gages shall be within the following tolerances:

INTERVALS	PERMISSIBLE DEVIATION OF READING FROM ACTUAL THICKNESS OF STANDARD STEEL GAGE
0 to 0.25 mm. (0 to 0.01 in.) incl.	±0.0025 mm. (0.0001 in.)
Over 0.25 mm. to 1.02 mm. (0.01 in. to 0.04 in.) incl.	±0.0051 mm. (0.0002 in.)
Over 1.02 mm. to 3.05 mm. (0.04 in. to 0.12 in.) incl.	±0.0102 mm. (0.0004 in.)

(*e*) Convenient means shall be provided for setting the pointer to the zero position.

(*f*) The micrometer shall be tested periodically as outlined above and if it does not conform to these requirements its mechanism should be readjusted.

Specimens. 9. Specimens shall consist of the original samples obtained in accordance with Section 2 (*a*).

Methods. 10. At least five readings shall be taken at regular intervals across the entire width of each specimen. When measuring paper less than 0.05 mm. (0.002 in.) in thickness, a sufficient number of layers to give a reading on the scale of not less than 0.13 mm. (0.005 in.) shall be used.

In making measurements the plunger shall be raised to a point where its lower surface is from 0.45 to 0.55 mm. above the surface of the paper specimen lying in contact with the surface of the fixed anvil. The plunger shall be dropped from this height on the paper without retarding its speed of descent. When the thickness is read, care shall be taken not to touch the instrument.

Report. 11. The average, maximum and minimum thicknesses obtained on each specimen shall be reported.

TENSILE BREAKING STRENGTH

Apparatus. 12. (*a*) A testing machine of the dead-weight pendulum type suitably designed for testing paper shall be used. The machine shall preferably be power driven.

(*b*) The capacity of the machine shall not exceed 113 kg. (250 lb.).

(*c*) The machine shall be graduated to read 1 lb. or 1 kg. or less per scale division for testing paper breaking at 22.7 kg. (50 lb.) or over, and to 0.5 lb. or 0.5 kg. or less for testing paper breaking under 22.7 kg. (50 lb.).

Specimens. 13. From each of the samples selected in accordance with Section 2 (*a*), specimens shall be cut at least ten in the machine direction and if practicable, ten in the cross-machine direction. The specimens shall not exceed 2.54 cm. (1 in.) in width and shall be 25.4 cm. (10 in.) in length with clean-cut edges.

Procedure. 14. (*a*) The ratio of the clearance distance between jaws to the width of the specimen shall not be less than 5 to 1 nor more than 10 to 1.

(*b*) The rate of travel of the movable jaw shall be constant. It shall preferably be 30.5 cm. (12 in.) per minute, but it may be within the limits of 28 cm. (11 in.) and 33 cm. (13 in.) per minute provided it is constant.

(*c*) All readings obtained when the paper breaks at or in the jaws shall be rejected.

Report. 15. (*a*) The results of the machine-direction specimens and the cross-machine-direction specimens shall be reported separately.

(*b*) The results shall be reported in kilograms or pounds together with the width of the specimen in centimeters or inches and also the average thickness.

(*c*) The maximum, minimum, and average breaking load shall be reported for the machine direction and the cross-machine direction.

TEARING STRENGTH

Apparatus. 16. The testing machine shall be of the pendulum impulse type so designed as to produce a tear approximately 4.2 cm. (1.66 in.) long. The knife mounted on the machine to cut the slit for the tear shall be maintained sharp.

Specimen. 17. The specimens shall be taken from the original samples obtained in accordance with Section 2 (*b*) and shall be cut 6.3 cm. (2.5 in.) in width and at least 6.3 cm. (2.5 in.) in length. Enough specimens shall be cut so that at least five readings in the machine direction and five readings in the cross-direction, if possible, can be obtained for each original sample.

Method. 18. Enough paper shall be torn so that the readings on the machine shall be not less than 10 nor more than 20 g., unless one paper alone yields a reading greater than 20 g., in which case only one paper shall be torn at one time. The specimens shall be so arranged that an equal number of tears originating from opposite edges of the specimens will be produced. Readings obtained when a tear deviates more than 6.3 mm. (0.25 in.) from a straight line, shall be rejected. The readings obtained shall be multiplied by the instrument constant corresponding to the number of sheets torn.

Report. 19. (*a*) The tearing strengths obtained on the machine-direction specimens and on the cross-direction specimens shall be reported separately in grams.

(*b*) The average, the maximum, and the minimum tearing strengths shall be reported for the machine-direction specimens. If possible, similar results shall be reported for the cross-direction specimens.

BURSTING STRENGTH

Apparatus. 20. The testing machine shall have a circular flexible diaphragm 6.44 sq. cm. (1 sq. in.) in area. The pressure chamber shall be filled with glycerin or other suitable pressure medium and shall contain no air spaces. The test specimen shall be held in position over the diaphragm in a clamp having a circular hole approximately 6.44 sq. cm. (1 sq. in.) in area so that the diaphragm will force the paper into the hole when pressure is applied under the diaphragm. The pressure exerted on the diaphragm shall be indicated on a dial, graduated to at least 0.23 kg. (0.5 lb.) for papers giving bursting strengths 18 kg. (40 lb.) or under. A dial graduated 0.45 kg. (1 lb.) may be used in testing papers which give higher bursting strengths. The machine may be either hand-operated or power-driven, the latter being preferable.

Specimen. 21. If practicable, the specimen shall be so cut from the stock as to permit ten bursting tests on a line across the sheet or roll.

Procedure. 22. Ten bursts shall be made. The testing machine shall be driven at a uniform speed of 120 r.p.m. until the specimen bursts.

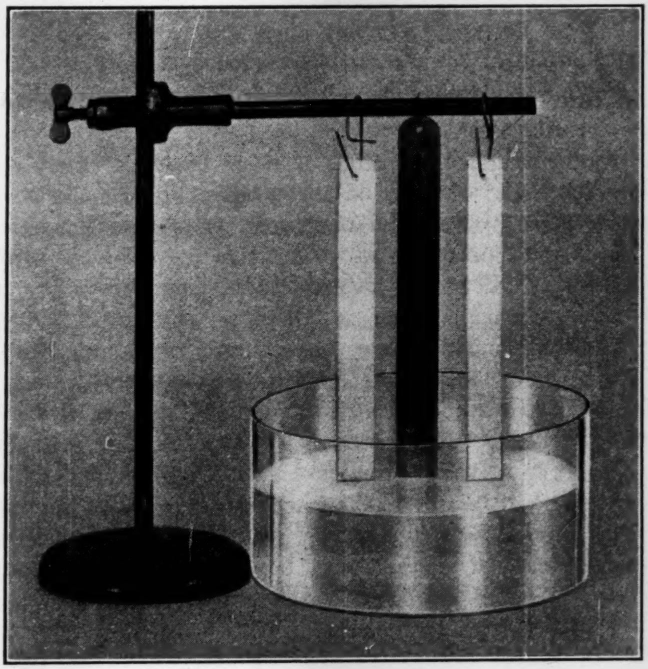

FIG. 1.—Apparatus for Absorption Test.

Report 23. The report shall include the average, the maximum, and the minimum results obtained.

ABSORPTION

(RISE OF WATER)

Apparatus. 24. A suitable container and support for specimens and scale is shown in Fig. 1.

Specimens. 25. Ten strips 2.5 cm. (1 in.) in width and at least 12.5 cm. (5 in.) in length shall be cut from the samples obtained in accordance with Section 2 (*a*), five being cut parallel with the machine direction of the paper and five being cut parallel with the cross-direction of the paper.

Procedure. 26. The specimens shall be suspended vertically with one end dipping 3.2 mm. (0.125 in.) in distilled water at room temperature.

After five minutes of suspension, the rise of the water in the paper above the water level shall be noted. The rise may be measured by reading directly from the scale the height of absorption.

Report. 27. The rise of water shall be reported in millimeters to the nearest 3 mm. or in inches to the nearest $\frac{1}{8}$ in.

MIL WEIGHT PER REAM
(APPARENT DENSITY)

Apparatus. 28. A scale, sharp knife, chemical balance and weighing bottle are necessary for the test.

Specimens. 29. Duplicate specimens shall be taken from as widely separated portions as possible from each of the samples obtained in accordance with Section 2 (*a*) and conditioned in accordance with Section 3.

Procedure. 30. (*a*) Each specimen while in the conditioned atmosphere (see Section 3) shall be cut accurately to any convenient size, for example, 232.3 sq. cm. (36 sq. in.) in area, and accurately weighed. Specimens of sufficient size to weigh at least from 3 to 5 g. (0.11 to 0.18 oz.) should be taken. If it is not possible to do the weighing in the conditioned atmosphere, the specimen shall be placed in a weighing bottle and tightly stoppered with a ground glass stopper before being removed from the conditioned atmosphere. The thickness of each specimen shall be determined in accordance with Section 10.

(*b*) *Mil Weight per Ream of Any Size.*—The mil (or point) weight in pounds per ream of any size may be calculated from the following formula:

$$W = 0.002205 \frac{mSN}{ta}$$

where m = the weight of the specimen expressed in grams;

t = the average thickness of the specimen expressed in mils (thousandths of an inch);

a = the area of the specimen expressed in square inches;

S = the area of one sheet in the basic ream expressed in square inches;

N = the number of sheets in the ream.

NOTE.—0.002205 is contracted from 0.00220462.

NOTE.—The following formulas may be used to calculate the mil weight in pounds per ream for reams of particular sizes, provided a specimen of exactly 232.3 sq. cm. (36 sq. in.) is used:

Ream of 24 by 36 in., 480 sheets.

$$W = 25.40 \frac{m}{t}$$

where m = the weight of specimen expressed in grams;

t = the average thickness of the specimen in mils (thousandths of an inch).

25.40 is contracted from 25.3972224.

Ream of 24 by 36 in., 500 sheets.

$$W = 26.45 \frac{m}{t}$$

where m and t are the same as above and 26.45 is contracted from 26.45544.

NOTE.—The ream weight may be obtained from the above formulas by omitting the thickness "t".

(*c*) *Weight per Unit Volume.*—The weight in pounds per cubic foot (density) may be calculated from the following formula:

$$D = 3810 \frac{m}{ta}$$

where m = the weight of the specimen expressed in grams.

t = the average thickness of the specimen expressed in mils (thousandths of an inch).

a = the area of the specimen expressed in square inches.

NOTE.—3810 is contracted from 3809.58336.

NOTE.—To convert weight in pounds per cubic foot to mil weight in pounds per ream of 24 by 36 in., 480 sheets, multiply by 0.24; to convert to mil weight in pounds per ream of 24 by 36 in., 500 sheets, multiply by 0.25.

Report. 31. The weight in pounds per cubic foot or the mil weight per ream shall be reported. The size of the ream must be given when the mil weight per ream is reported.

AIR RESISTANCE

Apparatus. 32. (*a*) The instrument shall consist of two aluminum open-top cylinders, one of which is inverted and slides into the other which is fixed. The movable cylinder shall be provided with a circular aperture in the closed end and a flat ring clamp for holding the paper specimen across this aperture.

(*b*) The fixed cylinder shall be 25.4 cm. (10 in.) in height and shall have an external diameter of 8.60 cm. (3.38 in.) and an internal diameter of 8.25 cm. (3.25 in.). Four slender bars, each 18.5 cm. (7.3 in.) long, 3 mm. (0.12 in.) wide and approximately 1.5 mm. (0.06 in.) thick shall be mounted vertically and equi-distantly on the inner surface of the fixed cylinder to act as guide tracks for the movable cylinder. The movable cylinder shall be graduated in units of 50 cc. and shall have a total range of 350 cc. It shall be 25.4 cm. (10 in.)

high and shall have an external diameter of 7.62 cm. (3.00 in.) and an internal diameter of 7.35 cm. (2.90 in.). It shall weigh, including the flat ring clamp and the two knurled nuts, 567 g. ± 0.5 g. (20 oz. ± 0.018 oz.). The movable cylinder and the flat ring clamp shall have a concentric circular aperture of 6.44 sq. cm. (1.00 sq. in.) in area When this aperture is too large for the specimen a similar movable cylinder and flat ring clamp having a concentric circular aperture of 1.61 sq. cm. (0.25 sq. in.) in area shall be used.

NOTE.—Results obtained with apertures of different areas are not directly proportional to the areas of the apertures. The proportionality factor must be determined by experiment.

Specimen. 33. The specimens shall be not less than 3.5 cm. (1.36 in.) nor more than 5.1 cm. (2.0 in.) in width cut from the original samples, taken according to Section 2 (*a*) and shall be as long as the width of the original roll of paper. If the specimens are selected from pads of tape they shall be not less than 2.1 cm. (0.81 in.) nor more than 5.1 cm. (2.0 in.) wide and at least 30 cm. (12 in.) long. There shall be as many specimens as there are original samples.

Procedure. 34. The fixed cylinder shall be placed on a rigid support so that its sides are vertical. A lubricating oil with viscosity of 60 to 70 seconds Saybolt at 37.8° C. (100° F.) shall be placed in it to a depth of 12.7 cm. (5 in.). The specimen (one thickness only) shall be secured tightly under the clamp on the movable cylinder completely covering the aperture. The movable cylinder is then floated on the lubricating oil. The time required for the displacement of a certain amount of air is noted with a stop-watch. If possible, the amount of air displaced should be such that the time of displacement is not less than 20 seconds. The apparatus with its content of lubricating oil shall be at the temperature of the conditioning room when the readings are taken. The time in seconds required for the displacement of 100 cc. (6.1 cu. in.) through a circular area (one side only) of 6.44 sq. cm. (1 sq. in.) of the paper is known as the air resistance of the paper.

NOTE.—The clamp shall be tested for leakage by substituting a piece of tinfoil 0.05 mm. (0.002 in.) in thickness for the paper and testing in the manner described above. When so tested, the leakage shall not exceed the rate of 50 cc. in five hours.

The proper procedure for clamping the specimen or tinfoil is to turn both knurled nuts down onto the clamp simultaneously. If only one nut at a time is turned down, the clamp will not fit flat on the specimen and will consequently have an avoidable leak.

Oil is used in preference to distilled water because it does not corrode aluminum whereas distilled water does.

Precautions should be taken to avoid subjecting the apparatus to vibration as this condition would increase the rate of air displacement.

35. The report shall include (1) the number of seconds required for the displacement of 100 cc. (6.1 cu. in.) of air; (2) the area of paper through which the air was displaced; (3) the thickness of the paper as obtained under Section 11 and (4) the room temperature. **Report.**

NOTE.—The following values show the probable accuracy obtainable in the air-resistance tests:

AIR RESISTANCE	ACCURACY
40 seconds	± 5 per cent
100 seconds	± 6 per cent
200 seconds	± 8 per cent
300 seconds	± 10 per cent

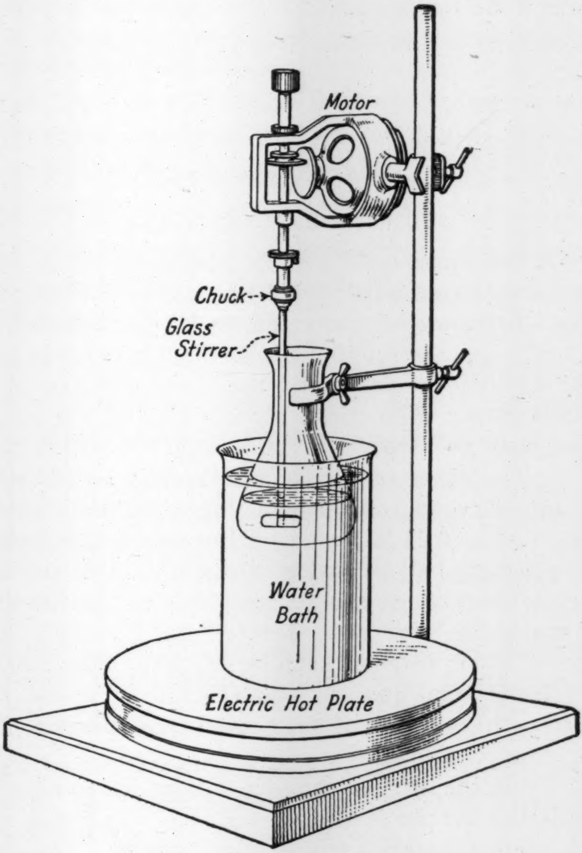

FIG. 2.—Extraction Apparatus.

ASH

36. A suitable crucible such as platinum, nickel or porcelain, a balance sensitive to 0.1 mg., and a desiccator are necessary for the test. **Apparatus.**

Specimen. 37. Not less than 2 g. of dry, finely-divided paper from the "moisture determination" sample as obtained in accordance with Section 6 shall be used.

Procedure. 38. The sample shall be transferred rapidly from the weighing bottle containing the dried sample into the crucible. The weighing bottle shall immediately be re-stoppered and re-weighed, and the exact weight of the sample obtained by taking the difference in weights of the weighing bottle and the sample. The sample shall be completely ignited in the crucible, preferably in a muffle furnace, all precautions being taken to prevent loss of ash or sample. The residue of incombustible mineral matter (ash) shall be desiccated, cooled and weighed, and the amount computed as a percentage of the weight of the dried sample.

Report. 39. The amount of ash shall be reported as a percentage of the weight of the dry sample (see Section 7 (*a*)) and also as a percentage of the weight of the undried sample (see Section 7 (*b*)).

ACIDITY OR ALKALINITY

Apparatus. 40. (*a*) A hot water bath, electric hot plate, motor with stirrer, 50-cc. glass burette graduated to 0.1 cc., 250-cc. wide-mouth Erlenmeyer flasks, thermometer graduated to 1° C., covering the range from 50 to 100° C., and a filtering apparatus, are required for the test.

(*b*) The Erlenmeyer flasks and the stirrer shall be of acid- and alkali-resistant glass. The stirrer shall consist of a glass shaft, one end of which shall be fitted to a chuck attached to the motor shaft (see Fig. 2). The other end of the stirrer shall be fashioned into a two-bladed propeller, each blade to be approximately 15 mm. (0.59 in.) long and 6 mm. (0.24 in.) wide. The pitch of the blades and the direction of rotation shall be such as to produce a downward current along the glass shaft when the stirrer is rotated in the liquid, thus preventing spattering.

(*c*) The following reagents shall be required: Solutions of sodium hydroxide (NaOH) and sulfuric acid (H_2SO_4) in water, each being 0.01 *N* in strength; solution of 0.5 g. of phenolphthalein dissolved in 100 cc. of c. p. ethyl alcohol.

Sample. 41. (*a*) From the original samples obtained according to Section 2 (*a*), a composite sample of at least 5 g. (0.175 oz.) shall be cut into small pieces, approximately 1 cm. (0.4 in.) square. The sample shall be thoroughly mixed and, during preparation, contamination by handling shall be avoided.

Procedure. 42. (*a*) *Extraction.*—One gram of the composite sample shall be placed in a 250-cc. Erlenmeyer flask and 100 cc. of boiling, distilled water added. The flask shall then be clamped in position in a water bath[1] heated to 100° C. on a hot plate. The level of the water in the bath shall be slightly above the level of that in the flask, and the temperature of the contents of the flask shall remain at least as high as 95° C. during the stirring operation. The stirrer shall be mounted so that the blades are within 3 mm. (0.12 in.) of the bottom of the flask and offset from the center in order to obtain best beating action. The stirrer shall be driven at a speed of 4000 to 5000 r.p.m. for 5 minutes. At the end of this period the sample should have been thoroughly pulped. For papers unusually difficult to pulp, the period of stirring shall be increased to 10 minutes.[2]

NOTE.—It has been definitely determined that 3000 r.p.m. is too low to pulp the sample effectively within 5 minutes.

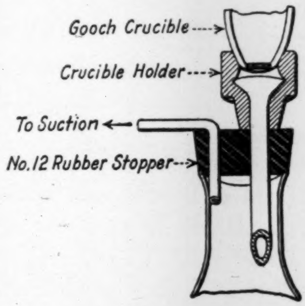

FIG. 3.—Filtration Apparatus.

(*b*) *Titration.*—Immediately after the sample has been pulped, the contents of the flask shall be filtered rapidly into another 250-cc. Erlenmeyer flask without washing.

NOTE.—It is important that the filtration of the extract be accomplished as promptly as possible after disintegration to prevent re-absorption of acidic or alkaline material from the extract by the pulp as the temperature falls. A convenient method consists of a 25-cc. porcelain Gooch crucible and holder assembly, like that shown in Fig. 3. The pulp forms a filter mat of itself over the perforations in the bottom of the crucible and the first portion of the filtrate is re-filtered to catch the fibers which go through during the formation of the mat.

The filtered extract shall be boiled for 3 minutes and immediately titrated before the temperature falls below 80° C., thus eliminating the error due to dissolved carbon dioxide.

If the extract is acidic, it is titrated with $0.01N$ NaOH, using 5 drops of the specified phenolphthalein solution as indicator. The end-point is determined by the appearance of a definite pink color. If the extract is alkaline, a small excess of 0.01N H_2SO_4 is added and the titration then completed with 0.01N NaOH as described above.

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[1] At high altitudes a salt bath will be necessary to obtain the temperature required.

[2] Any other method of pulping the sample as rapidly and thoroughly, while maintaining a temperature of 95° C. within the flask during extraction, should prove satisfactory.

NOTE.—To find the proper color transformation at the end-point, a blank titration should be made on boiling distilled water under the above specified conditions. The result should check with the curve shown in Fig. 4. This curve will be found valuable as a check on the purity of the distilled water used, although its chief purpose is to indicate the proper blank correction to be applied to the titration.

The number of cubic centimeters of titer solution shall be recorded, together with the temperature and volume of the solution taken immediately upon the completion of the titration, as these figures enter into the blank correction for the volume error (E_v).

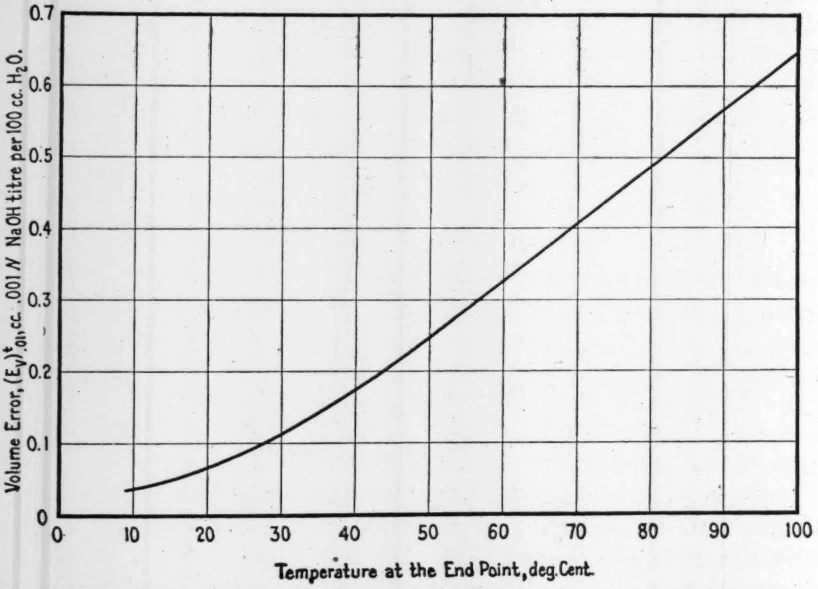

FIG. 4.—Showing Titration Error Due to Volume and Temperature of Water in a Solution at its End-Point.

If $(E_V)\frac{t}{N}$ represents the volume error of a solution where t and V are the temperature and volume at the end-point of a titration, and N = the normality of the titer, then it is calculated as follows:

$$(E_V)\frac{t}{N} = (E_V)^t 0.01 \times \frac{0.01}{N} \times \frac{V}{100}$$

Report. 43. (*a*) *Blank Correction.*—The correction for the blank error in the titration shall be made in either of two ways:

(*1*) By running a blank in parallel with the actual determination using a volume of pure distilled water equal to that of the extract at the end-point;

(*2*) By calculating the blank error with the aid of the curve shown in Fig. 4.

NOTE.—The second method is the more convenient and probably more reliable. This curve shows the number of cubic centimeters of $0.01N$ NaOH solution required to produce an end-point at various temperatures in 100 cc. of distilled water, using 5 drops of the specified indicator. Correction by the use of this curve is valid only if the solution has been boiled and titrated at elevated temperatures to insure absence of dissolved CO_2.

This correction is the number of cubic centimeters of titer solution (volume error) corresponding to the point on the curve determined by the temperature and volume of the solution at the end-point. If the solution is acidic, this blank correction shall be subtracted from the volume of titer used; if alkaline the correction shall be added.

(*b*) *Calculation.*—The acidity or alkalinity shall be calculated from the following equation:

$$\text{Percentage acidity (or alkalinity)} = \left\{\begin{matrix}\text{cubic centimeter titer}\\ \text{solution (corrected)}\end{matrix}\right\} \times \frac{\text{normality}}{1000} \times 40 \times 100$$

A simpler form is:

$$\text{Percentage acidity (or alkalinity)} = \left\{\begin{matrix}\text{cubic centimeter}\\ \text{titer (corrected)}\end{matrix}\right\} \times \text{normality} \times 4.$$

(*c*) *Expression of Results.*—The results shall be expressed as the equivalent weight per cent of NaOH if the extract is acidic, or as equivalent weight per cent of SO_3 if the extract is alkaline; this percentage being based on the weight of the air-dry sample in grams.

NOTE.—SO_3 is used rather than H_2SO_4 in this calculation as the equivalent weight of SO_3 is identical with that of NaOH, and this makes it possible to express acidity or alkalinity in directly comparable terms.

(*d*) *Number of Tests.*—At least two samples shall be carried through the foregoing procedure. If in duplicate samples the values of percentage acidity or alkalinity do not agree within 0.005, the determinations shall be repeated.

NOTE.—There is given in an appendix to the report of Committee D-9[1] for 1926, information regarding the details of the foregoing method, and reasons are presented for the selection of the conditions specified.

SURVEY FOR CONDUCTING PATHS

44. The survey for conducting paths in untreated insulating paper is a test to determine the number of conducting paths in the paper as indicated by the number of electrical breakdowns (or points of excessive current flow in thin papers (see Section 45 (*b*)) when relatively large areas of the paper are subjected to a voltage somewhat lower in value than the dielectric strength of the paper when tested in accordance with Sections 2 to 12 of the Tentative Methods of Testing Sheet and Tape Insulating Materials for Dielectric Strength **Scope.**

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[1] See *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 641 (1926).

(A.S.T.M. Designation: D 149 – 27 T) of the American Society for Testing Materials.[1]

Apparatus. 45. (*a*) The survey shall be made by passing a specimen of the paper between metallic electrodes across which a voltage is impressed. The arrangement of the apparatus may be of any convenient form which will allow the application of the required voltage to a specimen of relatively large area, and will allow the electrical breakdowns to be indicated so that the number of these may be counted.

(*b*) For papers having a thickness of 0.038 mm. (0.0015 in.) or less it has been found preferable to use a detecting device such as a telephone receiver to detect the excessive current through the conducting paths rather than to allow complete electrical breakdown of the specimen. Also, it is preferable to pass one electrode over the paper rather than to draw the paper through between the electrodes.

Specimens. 46. The specimen shall be of relatively large area, such as a pad of tape, or a sheet from each sample of paper (see Section 2 (*a*)). For sheet material such as pressboard either the entire sheet or a relatively large portion of a sheet shall be used. The specimen shall be representative of the shipment. (Section 2 (*a*)).

Procedure. 47. The survey shall be made by passing the specimen between the metallic electrodes at a speed of 30 to 60 ft. per minute. The voltage impressed across the electrodes shall be 100 volts per mil thickness of the specimen if alternating voltage is used, or 141 volts per mil thickness of the specimen if direct voltage is used.

NOTE 1.—If the voltage values specified above prove inconvenient of application, a lower voltage may be used, in which case it is necessary to establish a relationship between the conducting paths at this voltage and at the specified voltage. A lower value of conducting paths will be obtained at the lower voltage.

NOTE 2.—A description of equipment and a procedure which have been found suitable for making this survey of conducting paths in different thicknesses of paper may be had upon application to the secretary of Committee D-9.

Dielectric Strength. 48. The dielectric strength shall be determined in accordance with the Tentative Methods of Testing Sheet and Tape Insulating Materials for Dielectric Strength (A.S.T.M. Designation: D 149 – 27 T) of the American Society for Testing Materials.[1]

Report. 49. The report shall include the following:

(*a*) The total number of conducting paths and the conducting paths per unit area.

(*b*) The length, width, area, and thickness of the specimen.

(*c*) The voltage applied expressed in volts, and volts per mil thickness of specimen.

(*d*) The speed of the paper.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p.995 (1927); also 1929 Book of A.S.T.M. Tentative Standards, p. 577.

TENTATIVE METHODS OF TEST
FOR
RESISTIVITY OF INSULATING MATERIALS[1]

A.S.T.M. Designation: D 257 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1926; REVISED, 1929.

Scope.

1. These methods cover the determination of surface resistivity and volume resistivity of both solid and liquid insulating materials.

DEFINITIONS

Definitions.

2. (*a*) *Insulation Resistance.*—The insulation resistance between two electrodes which are fastened to or imbedded in a solid insulating material, or immersed in a liquid insulating material, is the ratio of the voltage applied to the electrodes to the total current which flows between the electrodes.

(*b*) *Volume Resistance.*—The volume resistance between two electrodes is the ratio of the electromotive force applied to the electrodes, to the current which flows through the volume of the insulating material.

(*c*) *Volume Resistivity.*—The volume resistivity is the resistance between two electrodes which cover opposite faces of a centimeter cube provided there is no surface layer or that the resistance of the surface layer is so high that no appreciable part of the current flows through it.

(*d*) *Surface Resistance.*—The surface resistance between two electrodes is the ratio of the electromotive force applied to the electrodes, to the current which flows through the surface layers.

(*e*) *Surface Resistivity.*—Surface resistivity is four times the resistance between two electrodes covering opposite faces of a cube when the volume resistance is so high that practically all of the current flows through the surface layers. This is equivalent to defining surface resistivity as the resistance between two opposite edges of a square of the surface layers.

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corp., 230 Grove St., Bloomfield, N. J.

NOTE 1.—(Applicable particularly to solids).—In the definition of Insulation Resistance, the total current may consist of two parts, that which flows through a surface layer, and that which flows through the volume of the material. The surface layer is any layer on the surface of an insulator in which the resistivity is different from that of the body of the material. The most common cause of such a layer is moisture which has been deposited on the material from the surrounding air. Insulating materials may be divided into three classes with respect to deposited moisture:

> *Class 1.* Materials which are not wetted by water. In the case of such materials the deposited moisture does not spread over the surface so that there is no true surface layer. Sulfur, paraffin, and the waxes are examples of such materials.
>
> *Class 2.* Materials which are wetted by water but which do not absorb it. In the case of these materials, the deposited moisture spreads over the surface forming a distinct surface layer. Examples of such materials are glass, quartz, amber, hard rubber, glazed porcelain, and slate. For many of these materials the resistivity of the water in the film is only one billionth part (10^{-9}) of the resistivity of the material. Hence, a film of water of a submicroscopic thickness which is often deposited on an insulator may conduct more current than flows through the body of the specimen.
>
> *Class 3.* Materials which absorb water. With these materials, there is no true surface layer, since deposited water is absorbed into the material. If the absorption takes place slowly, there may be a gradual gradation of properties on passing from the surface to the interior. Such materials do not have a true surface layer, since the change in resistivity is continuous. Examples of these materials are wood, paper, unglazed porcelain, and many molded and laminated compounds. This class includes a large part of the commercial insulating materials.

NOTE 2.—The definitions of Surface Resistance and Surface Resistivity are ordinarily applicable only to solid insulating materials.

NOTE 3.—In the definitions of Insulation Resistance, Volume Resistance and Surface Resistance, the resistances are defined in terms of the current which is not a constant but depends on the time that the circuit has been closed. After the circuit is closed, the current often changes quite rapidly. Theoretically, the current should not be read until it has become stationary. As this sometimes requires several hours, it is customary wherever possible to read the current one minute after closing the circuit. The resistance is usually computed from the value of the current at the end of one minute.

TEST SPECIMEN AND TYPE OF ELECTRODES

A. For Solid Insulating Materials

Test Specimen. 3. The test specimen for solid insulating materials shall be either in the form of a flat plate or a tube.

Material for Electrodes. 4. The material of the electrode is unimportant so long as good contact is made between the electrode and the insulating material. For a flat plate, mercury electrodes are very satisfactory though solid metal electrodes are often more convenient, and are satisfactory provided they make good contact. With a tube, a metal spray or conducting paint may be used. Conducting paint, however, shall not be used on a porous or absorbent material.

Electrodes.

5. *Measuring Volume and Surface Resistance.*—When both volume and surface resistance are to be measured, there shall be applied to each specimen three electrodes designated as the unguarded electrode, the guarded electrode, and the guard electrode. The method of applying these by means of a paint or spray to a tube is shown in Fig. 1. In the case of a tube specimen, the guard electrode shall be in two parts, one at either end of the tube. In the case of a flat specimen, the guard electrode shall be in the form of a ring surrounding

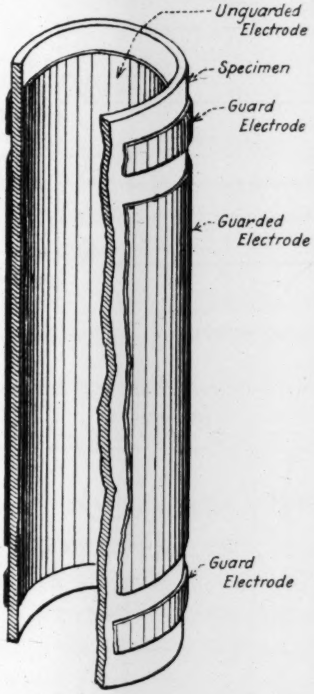

Unguarded Electrode
Specimen
Guard Electrode
Guarded Electrode
Guard Electrode

FIG. 1.—Application of Electrodes to Solid Tube Specimens.

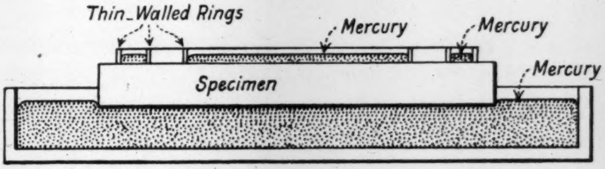
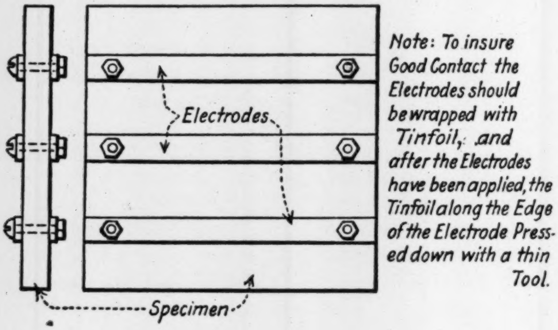

Thin-Walled Rings
Mercury
Mercury
Mercury
Specimen

FIG. 2.—Application of Electrodes to Flat, Solid Specimens.

the guarded electrode as shown in Fig. 2. In any case, the distance between the guarded electrode and the guard electrode shall be uniform and as large as 1 cm.

Special Electrodes.

6. (*a*) *Measuring Volume Resistance.*—If the surface resistance is high relative to the volume resistance, the guard electrode may be omitted in measuring volume resistance.



Note: To insure Good Contact the Electrodes should be wrapped with Tinfoil, and after the Electrodes have been applied, the Tinfoil along the Edge of the Electrode Pressed down with a thin Tool.

FIG. 3.—Application of Electrodes for Measuring Surface Resistance of Flat, Solid Specimens.

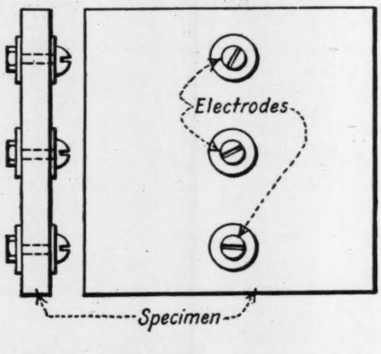


FIG. 4.—Application of Electrodes for Measuring Insulation Resistance of Flat, Solid Specimens.

(*b*) *Measuring Surface Resistance.*—If the volume resistance is high relative to the surface resistance, metal strips may be used as electrodes on flat plates in measuring surface resistance. One method of mounting these is shown in Fig. 3.

(*c*) *Measuring Insulation Resistance.*—Disk electrodes, as shown in Fig. 4, may often be advantageously used to measure insulation resistance where it is not necessary or not possible to separate it into volume and surface resistance. They may also be used to measure surface resistance under the same conditions as given in Paragraph (*b*).

B. For Liquid Insulating Materials

Sampling. 7. Samples of oil shall be obtained as described in Sections 2 to 7 of the Standard Methods of Testing Electrical Insulating Oils (A.S.T.M. Designation: D 117) of the American Society for Testing Materials.[1] Samples of other liquid dielectrics shall be obtained in a similar manner with regard to cleanliness of containers and sampling apparatus and shall be representative of the lot to be tested. The quantity of the sample depends upon the type of resistivity cell used, but in any case it shall be sufficient to permit three separate resistivity determinations.

Electrodes. 8. Suitable electrodes for liquid insulating material are parallel planes, concentric cylinders, or coaxial cones. The distance between the electrodes shall not be less than 0.75 mm. (0.03 in.) nor more than 5 mm. (0.2 in.). The voltage gradient shall not exceed 200 volts per millimeter (5 volts per mil). The area of the electrodes shall be sufficiently large so that the current flow can be measured, with the apparatus available, to an accuracy of 5 per cent.

Note 1.—Electrode areas of 50 to 500 sq. cm. (7.7 to 77.5 sq. in.) should prove suitable.

Note 2.—Because of the catalytic action of some metals on oils, the electrodes shall be nickel, gold or platinum-plated.

APPARATUS

Apparatus. 9. (*a*) The apparatus shall consist of a source of constant potential, a galvanometer with suitable shunts, a calibrating resistance, reversing switches and keys, and, if very high resistances are to be measured, a condenser. The apparatus shall conform to the requirements specified in Paragraphs (*b*) to (*f*):

(*b*) *Constant Potential.*—A dry or storage battery may be used as a constant source of potential.

(*c*) *Galvanometer.*—The galvanometer shall have a high-current sensitivity and will therefore have a high resistance. A sensitivity of 10^{-10} amperes per centimeter with scale at a meter distance is desirable. The most convenient shunt is the type known as a universal shunt whereby the current through the galvanometer may be changed by powers of ten without changing its damping.

(*d*) *Calibrating Resistance.*—The calibrating resistance shall be at least 100,000 ohms and preferably 1 megohm or more.

(*e*) *Switches and Keys.*—All switches and keys shall be mounted on high-grade insulating material. Paraffin is recommended wherever it can be used.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 796.

(*f*) *Condenser.*—The condenser shall have a high-insulation resistance and reasonably small absorption. Its capacitance shall be greater than 0.001 microfarad and preferably greater than 0.1 microfarad. A well-insulated air or mica condenser is satisfactory.

NOTE.—The apparatus described above will measure resistances as high as 10^{14} ohms. For higher resistances there must be observed special precautions such as the elimination of the conductivity of the surrounding air. A quadrant electrometer is often employed for measuring the extremely small currents which flow through a very high resistance. A method of using such an instrument is described in U. S. Bureau of Standards *Scientific Paper No. 324*, Vol. 11, p. 364.

MEASUREMENTS

Measurements for Volume and Surface Resistance.

10. The following measurements shall be made when both volume and surface resistance are to be determined:

(*a*) Area of the guarded electrode;

(*b*) Distance between the guarded electrode and the guard electrode;

(*c*) The insulation resistance between the guarded electrode and the unguarded electrode when the guard electrode is connected to the unguarded electrode;

(*d*) The volume resistance which is the resistance between the guarded electrode and the unguarded electrode when the guard electrode is maintained at the same potential as the guarded electrode;

(*e*) The temperature of the material under test;

(*f*) The relative humidity of the surroundings.

Measurements with Special Electrodes.

11. The following measurements shall be made when the guard electrode is not used:

(*a*) Area of the electrodes;

(*b*) Distance between or spacing of the electrodes;

(*c*) The insulation resistance between the electrodes;

(*d*) Temperature;

(*e*) Relative humidity.

NOTE 1.—The resistivity of all insulating materials changes considerably with temperature. It is, therefore, essential that the temperature of the specimen at the time of the measurement be recorded.

NOTE 2.—In the case of insulating oils it is often desirable to make measurements at an elevated temperature. For trade purposes resistivity at 85° C. or 100° C. is usually quoted.

Measurements for Laminated Materials.

12. In the case of laminated materials, both the surface and volume resistivities will depend on the direction of current flow. For a complete test, the volume resistance of laminated materials shall

be measured both along and across laminations. Likewise, the surface resistance shall be measured between three sets of electrodes, one on a surface parallel to the laminations and two on a surface perpendicular to the laminations. The electrodes to be used on the surface parallel to the laminations may be disks, parallel strips, or concentric circles. The two sets of electrodes to be used on the surface perpendicular to the laminations shall be strips, the edges of one set being parallel to the laminations and the edges of the other set perpendicular to the laminations.

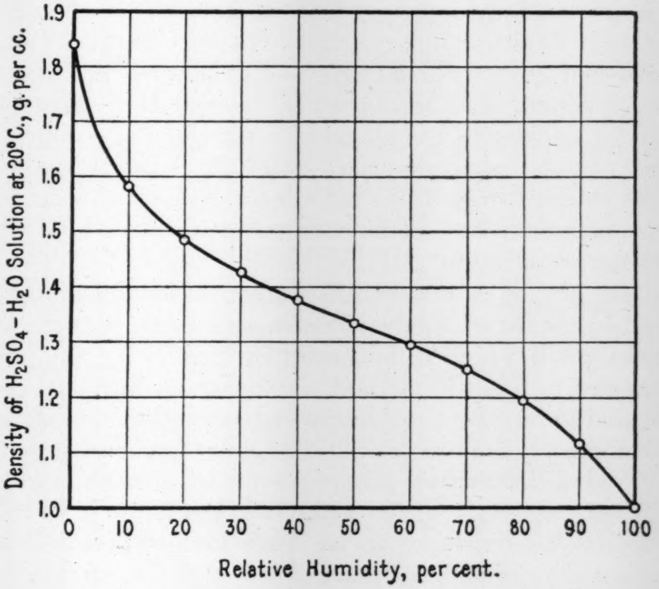

FIG. 5.—Relation of Relative Humidity of Air and Density of Acid-Water Mixture.

PROCEDURE

Humidity.

13. (*a*) Determinations of surface resistance shall be made only on specimens which have been kept for at least 48 hours in air at a definite humidity. Measurement of the insulation resistance of absorbing materials shall be made only on specimens which have been kept for 96 hours in air at a definite humidity. In either case, the specimen shall be kept undisturbed in air at this humidity during the determination. The measurements and resistivity determination shall be made without removing the specimen from the humidity chamber. For this purpose, highly insulated leads shall be passed through the walls of the chamber. This may be accomplished, even if the

humidity is very high, by cutting holes in the walls at least 2 cm. (0.80 in.) in diameter, closing them with stoppers of paraffin or sulfur, and bringing the leads out through the centers of these stoppers.

(*b*) *Humidity Control.*—The humidity may be readily maintained at any desired point by using an air-tight chamber in which a sulfuric acid - water mixture is exposed. The volume of the acid mixture shall be at least one-fiftieth of the volume of the chamber. The container for the mixture shall be an open vessel of such size that the area of the exposed liquid is at least three times as large as one side of a cube which would hold the required acid mixture. The density of the sulfuric acid - water mixture to give any desired humidity is shown by the curve in Fig. 5. No material which absorbs moisture, except those being tested, shall be allowed in the chamber. Provision shall be made for circulating the air and for maintaining the temperature constant. In case a lamp is placed inside the chamber, the specimens should be shielded from direct radiation. A desiccator may be used for a constant humidity chamber provided it can be kept where the temperature is constant.

Measurement of Resistance.

14. *Methods of Measuring Resistance.*—The resistance may be measured by means of a galvanometer used as an ammeter or if the resistances are too high to be measured directly by the use of the galvanometer, a ballistic method employing an auxiliary condenser may be used to increase the range of resistance that can be measured. The galvanometer shall have a suitable shunt for increasing its range. Figure 6 shows the diagram of connections from which it will be seen that it is only necessary to throw the switches to use it for measuring either the volume resistance or the insulation resistance of specimens of the types shown in Figs. 1 and 2.

Volume Resistance Determination.

15. The volume resistance shall be determined by either the galvanometer or ballistic method, as follows:

(*a*) *Galvanometer Method.*—With the galvanometer switch at B, with the guard switch at C, with the short-circuiting switch at E, and with the universal shunt set at low ratio (say 1:10,000) close the reversing switch in one direction and then close the key K_1. Increase the ratio of the universal shunt until a readable deflection is obtained on the galvanometer. Read the galvanometer deflection one minute after closing the reversing switch. Close the short-circuiting switch to F and leave it in this position for two minutes. Repeat measurement with the reversing switch closed in the opposite direction. If no appreciable deflection is obtained when the universal shunt ratio is 1 to 1, the resistance is too large to be measured by the galvanometer directly.

(*b*) *Ballistic Method.*—To measure very high resistances, throw the galvanometer switch shown in Fig. 6 to *A*, thus disconnecting the universal shunt. After closing the reversing switch and the key K_2 (this latter to prevent the charging current which flows into the specimen from passing through the galvanometer), close the key K_1. Open the key K_1 one minute after the reversing switch is closed. Now open key K_2. Three minutes after opening key K_1, close it again, thus discharging the condenser through the galvanometer. Read the ballistic deflection of the galvanometer. After short circuiting the specimen for two minutes, repeat the measurements with the reversing switch closed in the opposite direction. If no deflection is obtained with a leakage time of three minutes, the resistance is too high to be measured by the galvanometer.

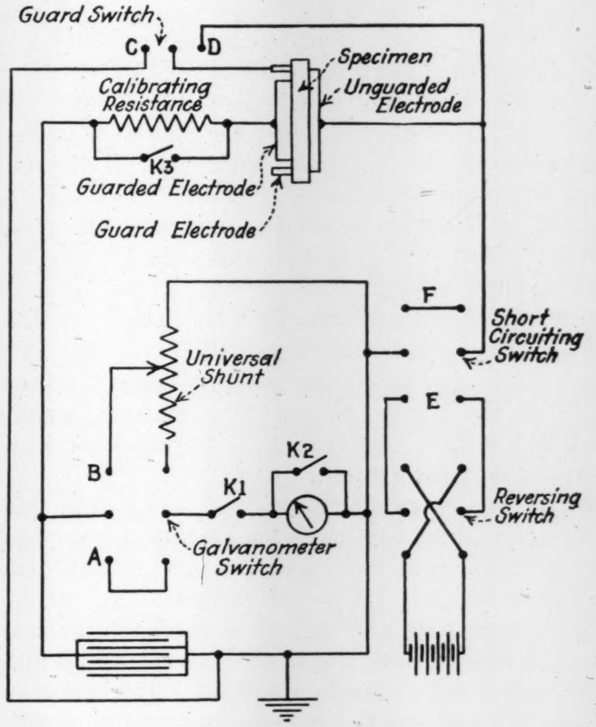
Guard Switch
C
D
Specimen
Calibrating Resistance
Unguarded Electrode
K3
Guarded Electrode
Guard Electrode
F
Short Circuiting Switch
Universal Shunt
E
K2
B
K1
Reversing Switch
A
Galvanometer Switch

FIG. 6.—Diagram of Connections for Resistivity Determinations.

16. The insulation resistance between the guard electrode and the guarded electrode, shall be determined in accordance with the

Insulation Resistance Determination.

procedure for measuring volume resistance as described in Sections 14 and 15, except that the guard switch shall be closed at D.

Precautions. 17. (*a*) *Mounting Specimens.*—In mounting the specimens for measurement, it is important that there shall be no conduction paths between the electrodes except those through the specimen. For example, the specimens shown in Figs. 3 and 4 shall be held by one or both edges so that no one of the electrodes touches the supports.

(*b*) *Measuring High Resistances.*—In measuring high resistances by the set-up shown in Fig. 6, it is important that all parts of the apparatus which are connected between the grounded sides of the battery and the guarded electrode shall be well insulated. In order to test whether the insulation is sufficient, the current through the galvanometer shall be negligible when the specimen is disconnected and the galvanometer and attached apparatus is maintained at a potential above ground, which is as high as that of this part of the circuit when the measurements of the resistance are being made. For this test, it is generally sufficient to replace the battery by a source of electromotive force having about one one-hundredth of the voltage of the battery. The ground shall then be changed to the opposite side of the battery so that it is connected to the lead going to the unguarded electrode. The circuit shall be opened at the guarded electrode. With the key K_1 closed the current through the galvanometer shall be less than 5 per cent of the current which flows through the specimen during measurement.

(*c*) *Measuring Volume Resistance.*—In measuring the volume resistance, it is important that there shall be no current flow between the guarded electrode and the guard electrode. This requires that the guarded electrode and the guard electrode shall at all times be at so nearly the same potential that the current flow between them is negligible. The exactness at which these electrodes shall be kept at the same potential will depend on the resistance between them as compared with the resistance of the specimen. In order to test this, the key K_3 shall be arranged to short circuit the calibrating resistance which is connected to the guarded electrode. With the direct deflection method, the galvanometer reading shall be the same with this key open and closed, unless the resistance of the specimen is of the same order of magnitude as the calibrating resistance.

(*d*) *High Humidity Atmosphere.*—With specimens in a high humidity atmosphere, the electrolytic action of the film of moisture at the metallic edges of the guard electrode and guarded electrode may produce an electromotive force. This will tend to send a current through the galvanometer. To test for this, it is only necessary to close the key K_1 with the galvanometer switch at *B* and the battery switch open. If the electromotive force is of importance, there will be a deflection of the galvanometer with the shunt set at the ratio used in making the measurement. No satisfactory readings can be made if this electromotive force gives an appreciable current. The only remedy is to use new electrodes.

CALCULATIONS

Volume Resistance.

18. If the calibrating resistance has a sufficiently high value, the resistance of a specimen, which may be measured by direct deflection, may be easily compared with the calibrating resistance. When measuring the specimen, call the shunt ratio *s*, and the galvanometer deflection *d*. Then open the guard switch and connect the guarded electrode to the unguarded electrode, thus short-circuiting the specimen. With the key K_1 closed, read the galvanometer deflection *D* and the shunt ratio *S*. Then, if the calibrating resistance has a value *M*, the volume resistance *R*, may be calculated from the formula:

$$R = M \cdot \frac{D}{d} \cdot \frac{S}{s}$$

If the calibrating resistance is so small that the battery used in the measurements will give too large a deflection of the galvanometer with the smallest shunt ratio, then it is necessary to calibrate by means of a low-voltage battery. The same measurements shall be made as in the previous case, but now it is necessary to know the voltage of the calibrating battery, *E*, and of the measuring battery, *e*. Then:

$$R = M \cdot \frac{D}{d} \cdot \frac{S}{s} \cdot \frac{e}{E}$$

When using the leakage method, the current, *i*, through the specimen is so nearly uniform during the time that the key K_1 is open, that the average value may be taken. Then $i = q/t$, where *q* is the quantity that collects on the condenser in time *t*. When discharged through the galvanometer, this quantity gives a ballistic deflection *d*. Hence, if the electromotive force of the battery is *e:*

$$R = \frac{e}{i} = \frac{et}{q} = \frac{et}{kd}$$

where *k* is the ballistic constant of the galvanometer. To determine *k*, a known quantity, *Q*, is discharged through the galvanometer. To obtain *Q*, a condenser of capacitance *C* is charged with a cell of voltage *E*. Then $Q = CE$. This quantity is discharged through the galvanometer giving a deflection *D*. It follows that:

$$k = \frac{Q}{D} = \frac{CE}{D}$$

This value of k may then be used in the above formula to determine R.

Volume Resistivity.

19. The volume resistivity, ρ, shall be calculated from the formula:

$$\rho = \frac{RA}{l}$$

where

R = the volume resistance;
A = the area of the guarded electrode; and
l = average thickness of the specimen.

Theoretically, certain corrections should be made to this formula. For instance, for specimens in the form of tubes, the exact solution would consider that the lines of flow are the radii of circles. This results in a logarithmic formula for the resistivity. However, by suitable expansion, the above formula gives the first approximation which is sufficient for this work. Also, this formula assumes that the lines of flow are straight from the edge of the guarded electrode to the unguarded electrode. This is not the case but the edge correction is negligible.

Surface Resistance.

20. *Surface Resistance.*—The surface resistance is the resistance between any two electrodes in either Fig. 3 or Fig. 4, provided the volume resistance is so high that practically all the current flows through the surface film. If the insulation and volume resistance have been measured by means of either of the specimens shown in Fig. 1 or Fig. 2, then the surface resistance may be calculated from the formula:

$$\frac{1}{R'} = \frac{1}{R_s} - \frac{1}{R} \quad \text{or} \quad R' = \frac{R_s R}{R - R_s}$$

where

R' = the surface resistance;
R_s = the insulation resistance; and
R = the volume resistance.

Unless R is at least 10 per cent greater than R_s, the value of R' shall be considered infinite, indicating no surface layer.

Surface Resistivity.

21. (*a*) The surface resistivity, σ, shall be calculated from the surface resistance and the size and position of the electrodes, from the following formula:

$$\sigma = \frac{R'b}{l}$$

where

σ = the surface resistivity;
R' = the surface resistance;
b = the average length of the electrodes;
l = the distance between the electrodes.

(*b*) In case the electrodes are concentric circles on the same side, as in the case of the flat specimen, as shown in Fig. 2, the length b is the mean of the circumference of the guarded electrode and of the inner edge of the guard electrode.

(*c*) In the case of the cylindrical specimen shown in Fig. 1, l is the average distance between the guarded electrode and each of the guard electrodes, while b is twice the circumference of the cylinder.

(*d*) If the electrodes are strips on a flat sheet, as shown in Fig. 3, l is the distance between the strips and b their length. In this case, however, b shall be at least ten times l in order that the correction for the end of the electrodes will be so small that it may be neglected.

(*e*) In case the electrodes are disks of equal size as shown in Fig. 4, the surface resistivity may be calculated from the formula:

$$\sigma = \frac{\pi R'}{\log_e \left[\frac{d}{2r} + \sqrt{\left(\frac{d}{2r}\right)^2 - 1} \right]}$$

where

d = the distance between the centers of the disks;
r = the radius of the disks.

If d has a value between $3r$ and $4r$, then the following approximate formula may be used:

$$\sigma = \frac{\pi}{2} \cdot \frac{R'(d + r)}{d - r}$$

REPORT

22. The report shall include the following: **Report.**

(*a*) The volume resistivity in ohm-cm. units;
(*b*) The surface resistivity (when determined) in ohms;
(*c*) The temperature in degrees Centigrade;
(*d*) The percentage relative humidity.

TENTATIVE METHODS
OF
TESTING VARNISHED CLOTHS AND VARNISHED CLOTH TAPES[1]

A.S.T.M. Designation: D 295 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1928; REVISED, 1929.

Scope. 1. These methods are intended to apply to varnished cloths and varnished cloth tapes which are to be used as electrical insulation and are directly applicable to both the "straight-cut" and "bias-cut" materials, unless otherwise stated in the method.

SAMPLING

Selecting Rolls. 2. (*a*) Shipments of varnished cloth and varnished cloth tapes shall be sampled as specified in Paragraphs (*b*) and (*c*) but no less than two rolls or pads shall be selected from any shipment. The rolls or pads shall be selected in such a manner as to be representative of the shipment.

(*b*) *Cloth.*—One roll shall be selected from each ten rolls in a shipment of full-width varnished cloth.

(*c*) *Tape.*—At least one roll or pad shall be selected from each 100 rolls or pads in a shipment of varnished cloth tape.

Selecting Samples. 3. (*a*) Not less than two turns of cloth or six turns of tape from each roll or pad selected for sampling shall be torn off and discarded before the samples are selected. The number of samples required for purposes of test shall then be cut across the entire width of each roll or pad. The length of the samples shall not be less than 91.44 cm. (36 in.) for straight-cut material; from seam to seam for sewed bias-cut material; and from jointed-selvage to jointed-selvage for seamless bias-cut material.

NOTE 1.—Specimens of bias materials cut in the above manner will exclude seams and jointed-selvages from the test areas.

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corp., 230 Grove St., Bloomfield, N. J.

NOTE 2.—If it is desired to test the seams or jointed-selvages for tensile breaking strength, additional specimens will have to be cut so that the seams or jointed-selvages are in the center of the specimens.

(*b*) From shipments such as sheets of cloth or strips of tape, the samples shall be representative of the shipment and shall be taken in accordance with Paragraph (*a*).

CONDITIONING

Conditioning. 4. Specimens shall be conditioned before testing for at least two hours in air maintained at a temperature between the limits of 20 and 30° C. (68 and 86° F.)

THICKNESS

Apparatus. 5. A micrometer[1] of the spring actuated, dial type shall be used. The plunger shall be capable of being raised by the application of an upward pressure to it. The plunger surface shall be circular in shape and 12.7 mm. (0.50 in.) in diameter. The anvil surface shall be plane and circular in shape, the diameter of which shall not be less than 12.7 mm. (0.50 in.). It shall be centered with respect to the plunger surface.

In addition to these requirements, the instrument shall conform to the following:

(*a*) The pressure applied to the plunger necessary to move the pointer from zero toward a positive reading shall not be greater than 1135 g. (40 oz.).

(*b*) The pressure applied to the plunger necessary to just prevent movement of the pointer from zero toward a lower reading shall not be less than 455 g. (16 oz.).

(*c*) The diameter of the dial shall be approximately 15 cm. (6 in.) and shall be graduated preferably in divisions indicating a thickness of 0.0127 mm. (0.0005 in.) and in no case greater than 0.0254 mm. (0.001 in.). Graduations indicating a thickness of 0.0254 mm. (0.001 in.) shall be at least 3 mm. (0.12 in.) apart.

(*d*) Measurements made on standard steel thickness gages shall be within the following tolerances:

INTERVALS	PERMISSIBLE DEVIATION OF READING FROM ACTUAL THICKNESS OF STANDARD STEEL GAGE
0 to 0.25 mm. (0 to 0.01 in.) incl.	±0.0025 mm. (0.0001 in.)
Over 0.25 mm. to 1.02 mm. (0.01 in. to 0.04 in.) incl.	±0.0051 mm. (0.0002 in.)
Over 1.02 mm. to 3.05 mm. (0.04 in. to 0.12 in.) incl.	±0.0102 mm. (0.0004 in.)

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[1] This apparatus is the same as that used for the testing of paper and described in Section 8 of the Tentative Methods of Testing Untreated Insulating Paper (A.S.T.M. Designation: D 202 - 29 T), see p. 760.

(*e*) Convenient means shall be provided for setting the pointer to the zero position.

(*f*) The micrometer shall be tested periodically as outlined above and if it does not conform to these requirements its mechanism should be readjusted.

Specimens. 6. Specimens for test shall consist of samples selected in accordance with Section 3.

Procedure. 7. In making thickness measurements, only one layer of material shall be used and the micrometer plunger shall be raised to a point where its lower surface is from 0.45 to 0.55 mm. (0.018 to 0.021 in.) above the surface of the specimen lying in contact with the surface of the fixed anvil. The plunger shall be dropped from this point on to the specimen without retarding its speed of descent. When the thickness is read, care shall be taken not to touch the instrument.

Number of Measurements. 8. In the case of cloths, five readings, equally spaced across the width of the specimen, and five readings, equally spaced along the length of the specimen, shall be taken and the thickness of the cloth shall be the average of the ten measurements.

(*b*) In the case of tapes, not more than five readings shall be taken equally spaced along each specimen length and the thickness of the tape shall be the average of ten measurements taken on at least two specimen lengths.

NOTE.—The average thickness, as obtained in Section 15 for the dielectric strength test, may be conveniently used instead of the separate test described above.

Report. 9. The report shall include the average, maximum and minimum thicknesses in millimeters or inches.

TENSILE BREAKING STRENGTH

Apparatus. 10. (*a*) A testing machine[1] of the dead-weight pendulum type shall be used. The machine shall preferably be power driven.

(*b*) The capacity of the machine shall not exceed 113 kg. (250 lb.).

(*c*) The machine shall be graduated to read 1 lb. or 1 kg. or less per scale division for testing specimens breaking at 22.7 kg. (50 lb.) or over, and to 0.5 lb. or 0.5 kg. or less for testing specimens breaking under 22.7 kg. (50 lb.).

Test Specimens. 11. Specimens cut from the full width cloth shall be 2.54 cm. (1 in.) in width and not less than 35.54 cm. (14 in.) in length. The tape specimens shall be of the original width and shall not be less than 35.54 cm. (14 in.) in length.

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[1] This apparatus is the same as that used for the testing of paper and described in Section 12 of the Tentative Methods of Testing Untreated Insulating Paper (A.S.T.M. Designation: D 202 – 29 T), see p. 761.

NOTE.—If it is desired to test the seams or jointed-selvages of bias-cut materials for tensile breaking strength, specimens obtained as described in Note 2 to Section 3 (*b*) shall be clamped in the testing machine so that the seams or jointed-selvages are midway between the two jaws. When testing, all readings obtained when the specimen breaks away from the seam or jointed-selvage shall be rejected.

Number of Specimens.

12. (*a*) In the case of straight-cut cloths, ten specimens shall be cut in the direction of the warp threads and ten in the direction of the filling threads from samples selected in accordance with Section 3.

(*b*) In the case of bias-cut cloths, ten specimens shall be cut in the direction of the length from samples selected in accordance with Section 3.

(*c*) In the case of tapes, ten specimens shall be cut from samples selected in accordance with Section 3.

Procedure.

13. (*a*) The ratio of the clearance distance between jaws to the width of the specimen shall not be less than 5 to 1 nor more than 10 to 1.

(*b*) The rate of travel of the movable jaw shall be constant and preferably 30.5 cm. (12 in.) per minute, but it may be within the limits of 28 cm. (11 in.) and 33 cm. (13 in.) per minute provided it is constant.

(*c*) All readings obtained when the specimen breaks at or in the jaws shall be rejected.

Report.

14. (*a*) The tensile breaking strength shall be the average of the breaking loads of the ten specimens. The report shall include the average, maximum and minimum breaking loads in kilograms or pounds together with the width of the specimen and the average thickness.

(*b*) In the case of straight-cut cloths, the tensile breaking strength of the warp threads and the filling threads shall be reported separately.

DIELECTRIC STRENGTH

Method.

15. The dielectric strength shall be determined in accordance with the Tentative Methods of Testing Sheet and Tape Insulating Materials for Dielectric Strength (A.S.T.M. Designation: D 149 - 27 T) of the American Society for Testing Materials.[1]

Specimens.

16. (*a*) In the case of cloths, a specimen at least 10.16 cm. (4 in.) in width shall be cut diagonally from corner to corner from a sample selected in accordance with Section 3.

(*b*) In the case of tapes, the specimens shall be samples selected in accordance with Section 3.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 995 (1927); also 1929 Book of A.S.T.M. Tentative Standards, p. 577.

Dielectric Strength.

17. (*a*) In the case of cloths, the dielectric strength shall be the average of the required number of puncturing voltages taken equally spaced along the specimen length.

(*b*) In the case of tapes, the dielectric strength shall be the average of the required number of puncturing voltages taken on at least two specimen lengths, one half the punctures being made equally spaced along each length.

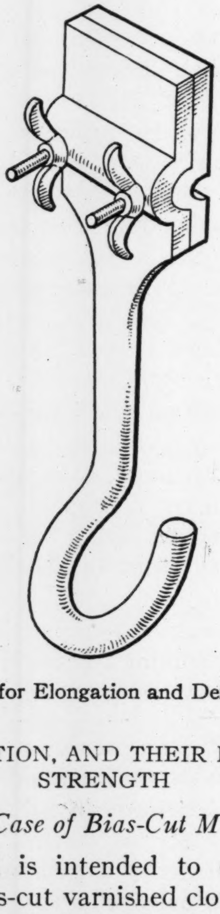

FIG. 1.—Clamp for Elongation and Deformation Test.

ELONGATION, DEFORMATION, AND THEIR EFFECT ON DIELECTRIC STRENGTH

(*In the Case of Bias-Cut Material*)

Scope.

18. (*a*) This method is intended to determine the effect of mechanical tension on bias-cut varnished cloths and tapes.

(*b*) When a bias-cut strip is weighted with a load, the length to which it will be stretched increases with time until it reaches a maximum value. The difference between this length and the original length is called the "elongation." For average material the time to reach maximum elongation is between 20 and 35 minutes.

(*c*) If the load is then removed from the strip, it decreases in length until it reaches a final elongation. The difference between this length and the original length is the amount of permanent elongation imparted to the material and is called the "deformation." For average material, the time to reach final elongation (deformation) is between 5 and 20 minutes.

NOTE.—It will be noted in the procedure for this determination (see Section 21) that the maximum time to reach elongation and deformation has been selected in each case, namely, 35 and 20 minutes, respectively.

(*d*) A characteristic feature of the test is that over the lower range of increasing loads the dielectric strength remains almost constant and the elongation and deformation are small; but as the load is increased the material stretches considerably, the elongation and deformation become large and the dielectric strength drops to a fraction of the original dielectric strength. Therefore, the load at which the dielectric strength is considerably lowered is considered the "critical load."

19. The apparatus required for the test shall consist of a pair of clamps for gripping the ends of the specimen. The clamps shall not be less than 5.08 cm. (2.0 in.) in width and one shall be provided with means for attaching to a fixed support and the other with means for affixing suspended weights. See Fig 1 for suggested form of clamp. **Apparatus.**

20. (*a*) In the case of bias-cut cloths, specimens shall be cut in the direction of the length from the samples selected in accordance with Section 3. They shall not exceed 3.81 cm. (1.5 in.) in width and shall be at least 91.44 cm. (36 in.) in length. **Specimens.**

(*b*) In the case of bias-cut tapes, specimens shall be samples selected in accordance with Section 3 and they shall not exceed 3.81 cm. (1.5 in.) in width. Tapes of greater width than this shall be cut to 3.81 cm. (1.5 in.) or less before testing.

(*c*) A set of three specimens shall be used for test at each load.

21. (*a*) *Elongation and Deformation.*—A set of three test specimens shall be tested individually at each load, as follows: A gage length, L, shall be marked on the test specimen and the specimen shall be fastened between the two clamps so that the test length is centrally located between the clamps. The gage length, L, shall be determined from the ratio: **Procedure.**

$$\frac{L}{W} = 10$$

where W = the width of the specimen.

The clearance distance, D, between the jaws of the clamps shall be determined from the ratio:

$$\frac{D}{W} = 22$$

The test specimen shall be weighted with a load M (including the weight of the clamp) and at the end of 35 minutes the distance between gage lines, L_1, shall be determined and the load then removed. After the load is removed the specimen decreases in length. At the end of 20 minutes after removing the load, the distance between the gage lines, L_2, shall be measured.

The percentage elongation and deformation shall be calculated from the following formulas:

$$\text{Percentage elongation} = \frac{L_1 - L}{L} \times 100;$$

$$\text{Percentage deformation} = \frac{L_2 - L}{L} \times 100$$

where L = the original gage length, in millimeters or inches;
L_1 = the distance between gage lines under load (maximum elongation), in millimeters or inches;
L_2 = the distance between gage lines after removal of the load (final elongation), in millimeters or inches.

The percentage elongation and deformation at each load shall be the average of the individual determinations made on the set of three specimens.

(*b*) *Dielectric Strength.*—After the determination of the deformation, five puncturing voltages shall be taken on the gage lengths of the set of three specimens in accordance with Method *A* for Short-Time Dielectric Strength Test as described in Sections 2 to 12 inclusive of the Tentative Methods of Testing Sheet and Tape Insulating Materials for Dielectric Strength (A.S.T.M. Designation: D 149 - 27 T) of the American Society for Testing Materials.[1]

(*c*) *Thickness.*—The thickness shall be determined in accordance with Sections 5 to 9 on the set of three specimens at each puncture, and the average of the five measurements shall be considered as the thickness.

Number of Tests. 22. The determinations described in Section 21 shall be repeated on sets of three specimens at gradually increasing loads (for example, M = 2, 4, 6, 8, etc., lb. per inch of width).

Graphical Record. 23. The results shall be represented graphically on the same sheet of graph paper by plotting as ordinates the average dielectric strength in volts per mil; the percentage elongation; and the percentage deformation against the load in kilograms or pounds as abscissa.

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[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 27, Part I, p. 995 (1927); also 1929 Book of A.S.T.M. Tentative Standards, p. 577.

24. The significant values which shall be reported are as follows: **Report.**

(*a*) The average dielectric strength in volts per mil at each load;

(*b*) The percentage elongation at each load;

(*c*) The percentage deformation at each load.

RESISTANCE TO OIL

25. The test for resistance to oil is a comparative test only. It is intended to give an indication of the effect of oil on the varnish film of the varnished cloth or tape. Results are determined by comparing a tested specimen with a specimen of the original material. **Scope.**

26. Three specimens, each 15.24 cm. (6.0 in.) in length, and not exceeding 3.81 cm. (1.5 in.) in width shall be cut from the samples and immersed for 48 hours in a specified oil, maintained at a temperature of 105 to 110° C. (221 to 230° F.). At the end of this time the specimens shall be removed from the oil, allowed to cool to room temperature and wiped with a piece of dry cheesecloth. **Specimens and Procedure.**

27. The effect of oil on the varnish film is indicated by evidence of disintegration, which may be detected by the following: **Examination.**

(*a*) The examination of the used oil for "turbidity."

NOTE.—The oil may be considered "turbid" if a sample of used oil filtered through filter paper can be distinguished from an unfiltered sample of the used oil when the two samples, in identical containers, are held in front of a diffused light.

(*b*) The examination of the varnish film for apparent softening or excessive tackiness.

(*c*) The partial or complete removal of the film on wiping.

28. The material shall be reported as passing the test when none of the strips show evidence of disintegration when examined in accordance with Section 27. **Report.**

RESISTANCE TO PETROLATUM

29. Three specimens, each 15.24 cm. (6.0 in.) in length, and not exceeding 3.81 cm. (1.5 in.) in width, shall be cut from the samples and immersed, for 15 minutes, in melted No. 5 (or better quality) petrolatum, maintained at a temperature of 150° C. (302° F.) to within ±5° C. (9° F.). At the end of this time, the specimens shall be removed from the petrolatum, wiped with a piece of dry cheesecloth and allowed to cool to room temperature. **Specimens and Procedure.**

30. For the effect of petrolatum on the varnish film, the specimens shall be examined in accordance with Section 27 (*b*) and (*c*). **Examination.**

31. The results shall be reported as specified in Section 28. **Report.**

WEIGHT

Weight. 32. Specimens of sufficient size to weigh not less than 5 g. (0.18 oz.) shall be accurately weighed on an analytical balance and the weight shall be reported on some commercial unit basis such as, the weight per square yard, the weight per gross yard per 1 in. in width, or the weight per roll.

THREADS PER INCH

Count. 33. The count or threads per inch of the varnished cloth or varnished cloth tape shall be determined separately on the warp and filling by counting a space of not less than 1 in. (2.54 cm.) in at least five different places in the sample strip (or strips). The average of the five determinations shall be the count.

Report. 34. The results of the warp count and the filling count shall be reported separately as threads per inch.

NOTE 1.—The warp threads in straight-cut materials are the threads which are parallel with the length dimension, while in bias-cut materials the warp threads are parallel with the seams and jointed-selvages.

NOTE 2.—Before counting black, varnished materials it will be necessary to remove the varnish film with a knife blade or other suitable instrument. Liquid varnish removers are unsuitable for this purpose as they cause a swelling of the fibers and a shrinkage of cloth with a consequent increase in threads per inch; therefore, the films must be removed mechanically.

TENTATIVE METHODS OF CHEMICAL ANALYSIS
OF
RUBBER PRODUCTS[1]

A.S.T.M. Designation: D 297 - 29 T

This is a **Tentative Standard**, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1928; REVISED, 1929.

(A) Short Procedure

GENERAL INSTRUCTIONS

Blanks.

1. Blank tests shall be run on all determinations and deductions made accordingly.

Checks.

2. In the event of any determination not falling within the limits given in these methods of test, a duplicate determination which shall agree within the limits specified shall be made and the average value taken as the true value.

Preparation of Specimen.

3. (*a*) A specimen weighing not less than 15 g. shall be prepared, taking pieces from various parts of the sample.

(*b*) The specimen shall be cut into small pieces and run through a grinder until all of it will pass through a No. 20 sieve.[2] Care must be taken that the grinder does not become appreciably warm. The backing shall be buffed off before grinding.

Removal of Iron and Care of Specimen.

4. A strong magnet shall be passed through the specimen to remove any metal from the grinder, and the specimen shall be mixed thoroughly and put in tightly stoppered bottles. It shall not be exposed to sunlight or heat.

REAGENTS

5. (*a*) *General Requirements.*—All reagents shall be of a purity equal to that called for in Krauch's "Standard Chemical Reagents, Their Purity and Use."

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. Arthur W. Carpenter, Secretary of Committee D-11 on Rubber Products, The B. F. Goodrich Co., Akron, Ohio.

These methods are essentially those adopted as standard by the American Chemical Society and the U. S. Bureau of Standards and include the Joint Rubber Insulation Committee's Procedure.

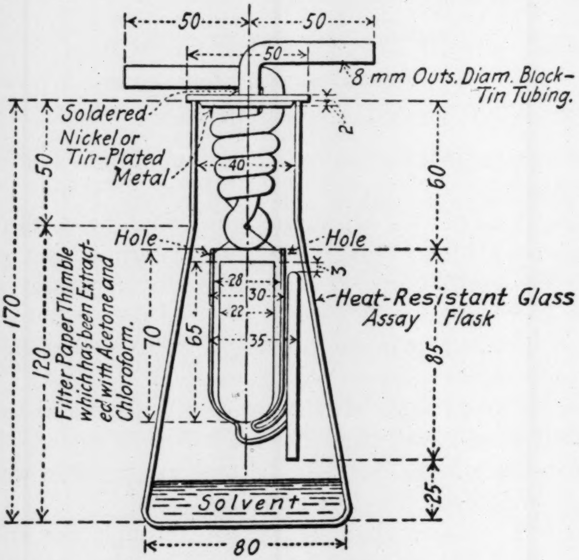
These methods will supersede, when adopted, the Chemical Tests appearing in Sections 1 to 47, inclusive, of the Standard Methods of Testing Rubber Products (A.S.T.M. Designation: D 15 - 24), see 1927 Book of A.S.T.M. Standards, Part II, p. 847.

[2] For detailed specifications for this sieve, see the Standard Specifications for Sieves for Testing Purposes (A.S.T.M. Designation: E 11) of the American Society for Testing Materials, 1927 Book of A.S.T.M. Standards, Part II, p. 917.

(*b*) *Acetone.*—Acetone shall be distilled not more than 10 days before use over anhydrous potassium carbonate, using the fraction which distills at 56 to 57° C.

(*c*) *Alcoholic-Potash Solution.*—Alcoholic potash shall be of normal strength, made by dissolving the required amount of KOH in absolute alcohol the day before use, and allowing to settle. Only the clear solution shall be used.

(*d*) *Barium-Chloride Solution.*—Barium-chloride solution shall be made by dissolving 100 g. of crystallized barium chloride in one liter of distilled water and adding two or three drops of concentrated HCl. If there is any insoluble matter or cloudiness, the solution shall be heated over night on the steam bath and filtered.


50
50
50
8 mm Outs. Diam. Block-Tin Tubing.
Soldered
Nickel or Tin-Plated Metal
40
2
50
60
Hole
Hole
3
28
30
22
35
Heat-Resistant Glass Assay Flask
170
120
Filter Paper Thimble which has been Extracted with Acetone and Chloroform.
70
65
85
25
Solvent
80

(All dimensions in millimeters.)

FIG. 1.—Extraction Apparatus.

METHODS OF ANALYSES

ACETONE EXTRACT

Extraction Apparatus. 6. The extraction apparatus shall conform to that shown in Fig. 1. It shall be heated so that the period of filling an empty siphon cup with acetone and completely emptying it will be between 2½ and 3½ minutes.

Procedure.

7. Two grams of the rubber shall be extracted continuously with acetone for 8 hours, using a sample that has been prepared within 24 hours. Distill off the acetone and dry the flask and contents for 4 hours at 95 to 100° C. Desiccate until cool and weigh. Continue to dry for 2-hour periods until constant weight is obtained. In drying place the flask on its side but at a sufficient angle from the horizontal so that the extract does not appreciably run down from the side of the flask.

FREE SULFUR

Free Sulfur.

8. Add to the flask containing the acetone extract 50 to 60 cc. of distilled water and 2 or 3 cc. of bromine (if the acetone extract indicates a large amount of free sulfur, the amount of bromine should be increased). Heat gently on the steam bath until the solution is practically colorless and filter into a 400-cc. beaker. Dilute with distilled water until the volume is about 400 cc. Cover the beaker with a watch glass, heat to boiling on the steam bath, add 10 cc. of barium-chloride solution (10-per-cent) and allow the precipitate to stand over night. The next day filter off the precipitate, ignite the filter paper and weigh.

ALCOHOLIC-POTASH EXTRACT

Alcoholic-Potash Extract.

9. Dry the residue from the acetone extraction at 50 to 60° C., put into a 200-cc. Erlenmeyer flask with 50 cc. of the alcoholic KOH solution and boil for 4 hours under a reflux condenser. Filter the solution into a beaker and wash twice, using each time 25 cc. of hot absolute alcohol and then wash thoroughly with hot water. Evaporate the solution to approximate dryness, take up in warm water and transfer to a separatory funnel. Acidify with 15 cc. of 5 *N* HCl, using this to rinse the beaker. Add sufficient water to make the bulk of the solution 100 cc. When cool, add 40 cc. of ether, using it to rinse the beaker in 20-cc. portions. Shake the aqueous and ethereal solutions thoroughly. After complete separation, draw off the aqueous solution and treat in another separatory funnel, with a fresh 20-cc. portion of ether. Continue to shake the aqueous solution with fresh portions of ether until a colorless portion has been obtained, then shake out twice more. Unite the ethereal solutions and wash with successive additions of water, continuing twice after the water shows no acid reaction. Filter through a plug of extracted cotton into a tared flask, wash the filter and funnel with ether, evaporate the ether without boiling and dry the residue to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

TOTAL SULFUR

Total Sulfur.

10. Mix a 0.5-g. sample with 4 g. of Na_2O_2 and 6 g. of K_2CO_3 in a dry 15-cc. iron crucible. Cover and heat gradually until the mixture fuses, proceeding cautiously, as rapid heating will cause an explosion. Then bring to quiet fusion for 15 to 20 minutes, applying heat so as to avoid contamination with sulfur fumes. Rotate the crucible while the melt solidifies. When cool, put crucible and cover into a casserole containing 200 cc. of water; add 5 to 10 cc. of bromine water and boil until the melt is dissolved. Allow the precipitate to settle, decant the liquid through a thick filter and wash the residue with hot water. Acidify the filtrate with HCl, evaporate to dryness and dehydrate if silica is present; add 2 cc. of concentrated HCl, take up in water, filter and wash, making the total volume about 400 cc. Heat to boiling and add slowly a slight excess of hot barium-chloride solution (10-per-cent). Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$ and calculate to sulfur.

ASH

Ash.

11. Weigh out a 1-g. sample in a porcelain crucible, heat in a muffle furnace, the temperature of which is carefully regulated so that no material amount of visible products are given off. After the mass is charred, the temperature shall be raised sufficiently to burn the carbon. The whole process shall be conducted at as low a temperature as possible. At the end of this operation the crucible shall be removed from the furnace, cooled in a desiccator and weighed; the ash broken up and inspected for carbon. If any visible carbon is present, a new determination shall be conducted.

CALCULATIONS

Calculations.

12. The percentage of rubber shall be considered to be the difference between 100 and the sum of the total sulfur and ash expressed as percentages and figured on the total compound. If the alcoholic-potash extract is over 2 per cent of the rubber as first calculated, subtract this excess also from the rubber. The organic-acetone extract shall be obtained by taking the difference between the total acetone extract and the free sulfur. The organic-acetone extract, free sulfur, total sulfur and alcoholic-potash extract shall be figured on the amount of gum as found by the above procedure.

CHECK ANALYSES

Check Analyses.

13. Duplicate determinations when required shall check within the following limits, expressed as percentages of the gum present, as found by analysis, except as stated:

	CHECK WITHIN, PER CENT
Organic-acetone extract	0.10
Free sulfur	0.10
Total sulfur	0.10
Alcoholic-potash extract	0.10
Ash calculated on total compound	0.25

(*B*) *Complete Procedure*

Scope.

14. These methods cover the complete procedure of analysis of rubber products to determine whether they comply chemically with specifications which are intended to secure compounds containing 30 per cent of the best Hevea rubber, and mineral fillers. In addition, there is a method which employs a solvent for the vulcanized rubber. This method has proved to be more accurate than an ash determination when carbonates are present in a rubber compound and may also be used in the analysis of asbestos rubber packings and rubberized fabrics.

DEFINITIONS

Definitions.

15. (*a*) *Acetone Extract.*—If the acetone extraction is made on a vulcanized compound, the acetone removes the rubber resins, the free sulfur, any mineral oils or waxes, and part of any bituminous substances or vulcanized oils that may have been used. This is generally called acetone extract uncorrected. The percentage of free sulfur and the percentage of waxy hydrocarbons are determined and their sum deducted from the total extract. The value obtained is known as acetone extract corrected. The corrected figure thus obtained will at times give valuable information regarding the quality of the rubber present. For the best grades of Hevea rubber this should not exceed 5 per cent of the rubber present. A higher extract may indicate the presence of inferior or reclaimed rubbers.

(*b*) *Chloroform Extract.*—The chloroform extraction removes a portion of the bituminous substances and serves as an indication of their presence. The chloroform extract may also include other materials.

(*c*) *Alcoholic-Potash Extract.*—The purpose of the alcoholic-potash extraction is to detect the presence of rubber substitutes.

(*d*) *Free Sulfur.*—Free sulfur is that which is removed during the acetone extraction.

(*e*) *Total Sulfur.*—Total sulfur is the sulfur that occurs in the compound, either free or chemically combined, unless barium sulfate is present, in which case the amount of sulfur in it is deducted from the amount of total sulfur.

(*f*) *Ash.*—The ash is the residue left after ignition and consists principally of the non-volatile mineral fillers, together with their reaction products with sulfur.

(*g*) *Sulfur in Ash.*—The sulfur in ash consists of the sulfur from the mineral fillers and also part of the sulfur that was with the rubber, but which during ignition enters into combination with mineral fillers.

(*h*) *Total Compounding Ingredients.*—Total compounding ingredients consist of the residue obtained when the rubber is dissolved by mineral oil in the solution method of analysis. Total compounding ingredients corrected is the value obtained after deducting sulfur and organic matter present.

Special Determinations. 16. Special methods are given for the analysis of compounds that contain glue, carbon, antimony, and waxy bydrocarbons.

Indirect Methods. 17. (*a*) Up to the present time, no simple method has been devised for the direct determination of the amount of rubber present in a vulcanized compound. Therefore, an indirect method is proposed which will give satisfactory results in all cases known today, except where there are found to be present decomposible compounding ingredients, such as carbonates, cellulose, and high percentages of mineral rubbers. As practically all insulating compounds contain some of these ingredients, the said compounds when specified shall be analyzed in accordance with the Joint Rubber Insulation Committee's Procedure as described in Section 45.

(*b*) When carbonates, talc, and asbestine are present more accurate results are obtained by the use of the Joint Rubber Insulation Committee's Procedure described in Section 45, or by the Rubber Solvent Method described in Sections 57 to 60, inclusive.

(*c*) If high percentages of mineral rubber are used, no accurate method is known. If cellulose is present the best results are obtained by the method described in Section 46.

REAGENTS

Reagents. 18. (*a*) *Acetone.*—The acetone shall be chemically pure and shall be freshly redistilled over anhydrous sodium carbonate, using the 56 to 57° C. fraction.

(*b*) *Alcoholic-Potash Solution.*—The alcoholic-potash solution shall be of normal strength. It shall be made by dissolving the required amount of KOH in alcohol which has been purified as follows:

Dissolve 1.5 g. of $AgNO_3$ in 3 cc. of water and add it to 1000 cc. of alcohol. Dissolve 3 g. of KOH in the smallest amount of hot water, cool, add it to the alcoholic-silver nitrate solution, and shake thoroughly. Allow the solution to stand for at least 24 hours, filter, and distill. (Alcohol denatured with 10 per cent by volume of methanol may be used in place of ethyl alcohol.)

(*c*) *Nitric Acid-Bromine Solution.*—The nitric acid-bromine solution shall be prepared by adding a considerable excess of bromine to concentrated HNO_3 and shaking thoroughly.

(*d*) *Zinc-Nitric Acid Solution.*– The zinc-nitric acid solution is made by adding 200 g. of zinc oxide to 1000 cc. of concentrated HNO_3.

(*e*) *Barium-Chloride Solution.*—Barium-chloride solution shall be made by dissolving 100 g. of crystallized barium chloride in 1 liter of distilled water, and adding two to three drops of concentrated HCl. If there is any insoluble matter or cloudiness, the solution shall be heated overnight on the steam bath and filtered.

(*f*) *Standard 0.1 N Potassium Permanganate Solution.*—Dissolve approximately 3.1 g. of potassium permanganate in 1 liter of water, and after about one month filter through an ignited asbestos pad. Weigh 0.25 g. of pure metallic antimony and transfer it to a 600-cc. Erlenmeyer flask. Add 12 to 15 cc. of concentrated H_2SO_4, 10 to 12 g. of potassium sulfate, and heat until all the antimony is dissolved. Dilute to 250 cc. with water, add 20 cc. of concentrated HCl, cool to 10 to 15° C., and titrate with permanganate solution until a faint pink color is obtained.

$$1 \text{ cc. of } 0.1\ N\ KMnO_4 = \frac{\text{Wt. of metallic antimony}}{\text{cubic centimeters of permanganate}}$$

(*g*) *Starch Iodate Paper.*—Starch iodate paper is prepared by impregnating filter paper with a solution obtained by heating 2 g. of starch with 100 cc. of water and, after solution, adding 0.2 g. of potassium iodate dissolved in 5 cc. of water.

(*h*) *Rubber Solvent.*—The mineral oil used in the solution method of determining rubber and fillers shall have approximately the following properties: Vicosity at 68° F., 56 seconds; at 100° F., 45 seconds; flash point 270° F.; fire point 350° F.; and specific gravity 0.853, and shall be colorless.

(*i*) *Asbestos Gooch Crucible.*—Prepare a Gooch crucible in the following manner: Amphibole asbestos is cut fine with shears, digested with caustic-soda solution (10-per-cent), washed with water, and then digested with concentrated HCl for a few hours on the steam bath. After it has been washed comparatively free from acid by decantation, the asbestos is shaken up with water and the resulting mixture is used in preparing the pad. The Gooch crucible is ignited, and is then ready for use.

BLANK ANALYSES

Blank Analyses.

19. The purity of all materials shall be checked and determined by blank analyses.

PREPARATION OF SAMPLES

Preparation of Samples.

20. (*a*) Before preparing a sample for analysis the analyst shall, by inspection, assure himself that it has not been contaminated. The sample shall be prepared by taking pieces from various parts of the original sample and separating them from foreign matter. The rubber shall be ground to the required fineness on a rubber mill or cut with scissors so as to pass a No. 14 sieve. Hard rubber should be prepared by rasping with a coarse file, cleaning with a magnet, and passing through a No. 14 sieve.

(*b*) Crude, reclaimed, or unvulcanized rubber shall be sheeted out very thin on an experimental mill and shall be rolled in holland or other cotton cloth to prevent the sample from sticking. If no mill is available, the sample shall be cut with scissors as fine as possible.

(*c*) Samples of rubberized cloth shall be prepared by cutting into pieces, 1.5 mm. square, and then mixing well.

(*d*) *Cements.*—Evaporate to dryness in a vacuum and analyze the residue as an unvulcanized sample. Distill a separate sample under reduced pressure if examination of the solvent is desired.

PRELIMINARY EXAMINATION OF SAMPLE

Carbonates.

21. Drop a small piece of the sample into a test tube containing concentrated HCl saturated with bromine. If a stream of bubbles is given off, the Rubber Solvent Method described in Sections 57 to 60, inclusive, shall be used.

Antimony.

22. Place a portion of the sample in a porcelain crucible and burn off the rubber. Treat the ash with concentrated HCl. Dilute the solution to 10 times its volume, filter and saturate with H_2S. If a precipitate of antimony sulfide is formed, the method described in Section 38 or the Rubber Solvent Method in Sections 57 to 60, inclusive, should be used.

Carbon Black.

23. Heat a portion of the sample with concentrated HNO_3 until there is no more frothing. If the liquid is black, it indicates the presence of free carbon, and the test for this substance should be made.

Barium Salts.

24. A qualitative test for barium can conveniently be made on the residue after filtration in the total sulfur determination as described in Section 33, by dissolving it in HCl (10-per-cent), filtering and then adding a few drops of H_2SO_4 (10-per-cent). A white pre-

cipitate of barium sulfate indicates the presence of barium in the sample.

Paraffin. 25. If paraffin is present, it will solidify in the cold acetone extract as a white flucculent precipitate clinging to the sides of the flask.

Glue. 26. Extract a portion of the sample with a mixture of 32 per cent acetone and 68 per cent chloroform by volume for 8 hours. Dry the sample and digest for 1 hour with hot water. Filter, cool, and add a few drops of a freshly prepared solution of tannic acid (2-per-cent) and allow to stand for a few minutes. If the solution becomes turbid, glue is present and should be determined as described in Section 41.

METHODS OF ANALYSES

SPECIFIC GRAVITY

Specific Gravity. 27. Specific gravity shall be determined by the use of a pycnometer, using alcohol in place of water, to eliminate the errors due to air bubbles:

$$\text{Sp. gr.} = \frac{C}{C - (B - A)} \times \text{sp. gr. of alcohol}$$

where A = weight of the pycnometer filled with alcohol,
B = weight of the pycnometer filled with sample and alcohol,
C = weight of the sample.

ACETONE EXTRACT

Extraction Apparatus. 28. The extraction apparatus used here and for other extractions shall be of the type shown in Fig. 1. The flask shall be heated so that the period of filling an empty siphon cup with acetone and completely emptying it will be between 2.5 and 3.5 minutes.

Procedure. 29. Place 2 g. of rubber in a thimble made by folding a filter paper so that it will fit in the extraction cup, which is suspended in a weighed extraction flask. Extract the sample continuously for 8 hours, unless the solution in the thimble is still colored at the end of that time, when the extraction shall proceed for a further period of 4 hours or longer. For hard rubber the extraction period shall be a minimum of 72 hours. Carefully note all characteristics of the acetone extract, both when hot and cold. Distill off the acetone on a steam bath, recovering the acetone if desirable, at as low a temperature as possible. Loss of extract by bumping can be avoided by means of a gentle current of air. Care must be taken to avoid allowing the flasks to stand on the steam bath after the solvent has been removed, because appreciable quantities of free sulfur may be lost by so doing. Dry the extraction flask and contents in an air bath for 1 hour at 70° C., cool, and weigh. Call the residue "acetone extract, uncorrected." Keep the sample for future determinations.

$$\text{Percentage of acetone extract, uncorrected} = \frac{\text{Wt. of extract}}{\text{Wt. of sample}} \times 100$$

CHLOROFORM EXTRACT

Chloroform Extract.

30. The rubber sample (see Sections 28 and 29) is suspended in a second weighed extraction flask and extracted for 4 hours with chloroform. Care should be taken that any small particles of rubber, which are often carried down into the extract, are filtered off. Evaporate off the solvent and dry to constant weight, usually 1 hour at 70° C., cool, and weigh. The color of the chloroform solution should be recorded. Reserve the rubber for extraction with alcoholic potash.

$$\text{Percentage of chloroform extract} = \frac{\text{Wt. of extract}}{\text{Wt. of sample}} \times 100$$

ALCOHOLIC-POTASH EXTRACT

Alcoholic-Potash Extract.

31. Dry the rubber from the chloroform extraction at about 70° C. to remove the chloroform, transfer to a 200-cc. Erlenmeyer flask, add 50 cc. of alcoholic-potash solution, and heat under a reflux condenser for 4 hours. Filter into a 250-cc. beaker, wash with two 25-cc. portions of boiling alcohol; then with three 25-cc. portions of boiling water, and evaporate the filtrate just to dryness. Use about 75 cc. of distilled water to transfer the residue to a separatory funnel. Acidify the solution with HCl (10-per-cent), testing with Congo red paper. Extract with four 25-cc. portions of ether, unless the fourth portion should be colored, when the extraction must be continued until no further quantity can be removed. Unite the ether fractions and wash thoroughly with distilled water until free from acid (two washings are generally sufficient). Filter the ether solution through a plug of absorbent cotton into a weighed flask, wash with ether, evaporate, dry to constant weight at 70° C., cool, and weigh.

$$\text{Percentage of alcoholic-potash extract} = \frac{\text{Wt. of extract}}{\text{Wt. of sample}} \times 100$$

FREE SULFUR

Free Sulfur.

32. Add to the flask containing the acetone extract, uncorrected (Sections 28 and 29), 60 cc. of distilled water and 2 to 3 cc. of bromine,

and cover with a watch glass. Allow the flask to stand 30 minutes on the side of the steam bath, then heat cautiously over the direct steam bath until the solution is practically colorless, filter into a 250-cc. beaker, and dilute to about 175 cc. with distilled water. Precipitate with barium chloride and determine in the usual manner.

$$\text{Percentage of free sulfur} = \frac{\text{Wt. of } BaSO_4 \times 0.1373}{\text{Wt. of sample}} \times 100$$

TOTAL SULFUR

Total Sulfur, Recommended Method.

33. Place 0.5 g. of rubber in a porcelain crucible of about 75-cc. capacity, add 15 cc. of the nitric acid-bromine mixture, cover the crucible with a watch glass, and let it stand for 1 hour in the cold. Heat for 1 hour on the steam bath, remove the cover, rinse it with a little distilled water, and evaporate to dryness. Add 3 cc. of HNO_3, cover, warm a short time on the steam bath, then let it cool. Carefully add in small portions, by means of a glass spatula, 5 g. of sodium carbonate (weighed to 0.5 g.). The watch glass is to be raised only high enough to permit the introduction of the spatula. The carbonate is allowed to slide down the side of the crucible and is not dropped directly into the acid. Rinse the watch glass with 2 or 3 cc. of hot distilled water and stir the mixture thoroughly with a glass rod. Digest for a few minutes, spread the mixture halfway up the side of the crucible to facilitate drying, and dry on a steam bath. Fuse the mixture by heating over a sulfur-free gasoline flame.

Place the crucible in an inclined position on a wire triangle and start the ignition over a low flame. The tendency for the organic matter to burn too briskly is controlled by judicious use of the stirring rod with which the burning portion is scraped away from the rest. When part of the mass is burned white, a fresh portion is worked into it until all of the organic matter is destroyed. It is necessary to hold the edge of the crucible with tongs. Toward the last half of the operation the flame should be increased. It is unnecessary to heat the crucible to redness. With care, a crucible can be used for at least 10 to 12 fusions.

After a fusion, allow the crucible to cool, place it in a 400 cc. beaker, add sufficient distilled water to cover the crucible (about 125 cc.), and digest on the steam bath for 2 hours, with occasional stirring. If the filtration can not be made on the same day, do not add the water, but allow the fusion to stand overnight.

Filter the solution into a covered 400-cc. beaker containing 5 cc. of concentrated HCl, and wash the residue thoroughly with hot water. (A qualitative test for barium can be made on the residue.) Complete the acidification of the filtrate and washings and add 2 cc. of concentrated HCl in excess. Cover the beaker and heat the solution on the steam bath. The total volume of the solution should be 300 cc. The solution must be acid to Congo paper in order to insure the complete destruction of the carbonates. Precipitate with barium chloride and determine the sulfur in the usual manner.

$$\text{Percentage of total sulfur} = \frac{\text{Wt. of BaSO}_4 \times 0.1373}{\text{Wt. of sample}} \times 100$$

Total Sulfur, Alternate Method.

34. *Alternate Method.*—When this method is used the total sulfur determined represents the sulfur exclusive of that originally present as barytes or formed from barium salts, if present in the compound.

Place a 0.5-g. sample in a 500-cc. Erlenmeyer destruction flask (Pyrex glass). Add 10 cc. of zinc oxide - nitric acid solution and moisten the sample thoroughly. If convenient, the mixture may be allowed to stand overnight. By so doing the sample becomes partly decomposed; this permits the addition of fuming HNO_3 with no danger of ignition of the sample. Add 15 cc. of fuming HNO_3 and whirl the flask rapidly to keep the sample immersed to avoid ignition by too rapid oxidation. With some samples it will be found necessary to cool the flask under a stream of tap water.

When the solution of the rubber is complete, add 5 cc. of a saturated water solution of bromine and slowly evaporate the mixture to a foamy sirup. (For the determination of total sulfur in unvulcanized mixtures use 3 cc. of bromine in place of bromine water.)

If particles of organic matter remain at the end of the evaporation, add a few cubic centimeters of fuming HNO_3 and re-evaporate as before. Cool, and add a few crystals of potassium chlorate to assist in the oxidation of the sulfur and the decomposition of any nitrates.

Place the flask on asbestos gauze and evaporate the mixture to dryness over a Tirrill burner. Then bake the mixture at the highest temperature of the burner until all nitrates are decomposed and no more nitrogen peroxide fumes can be detected. When the baking is complete, cool the flask, add 50 cc. of HCl (1:6) and heat until solution is complete. (In case the original mixture contains barium sulfate or other barium salts, they will be precipitated at this point with consequent loss of sulfur in the case of the latter. If litharge is present in the mixture, lead salts, not otherwise removed, will be eliminated in the final washing with boiling water.) Filter the solution, dilute to 300 cc., precipitate with barium chloride, and determine the sulfur in the usual manner.

$$\text{Percentage of total sulfur} = \frac{\text{Wt. of BaSO}_4 \times 0.1373}{\text{Wt. of sample}} \times 100$$

ASH

Ash.

35. Wrap a 1-g. sample in a filter paper, extract with acetone for 4 hours, and transfer to a weighed, approximately 50-cc. porcelain crucible. Ash the sample in a muffle furnace by heating at the following rate:

Time, minutes	0	5	10	15	70	75	80	85	145
Temperature, deg. Centigrade	0	100	200	300	300	400	500	550	550

Remove the crucible from the furnace, cool, and weigh.

$$\text{Percentage of ash} = \frac{\text{Wt. of ash}}{\text{Wt. of sample}} \times 100$$

If no furnace is available, distill off the rubber over a very small flame, not allowing it to catch fire, and ignite gently until burnt clean, cool, weigh, and determine ash in the usual manner.

SULFUR IN ASH

Sulfur in Ash.

36. Add 3 cc. of nitric acid - bromine mixture to the ash (see Section 35), cover with a watch glass and heat for 1 hour, remove the cover, rinse it with a little distilled water, and evaporate to dryness. Complete the determination of sulfur as described in Section 33.

Save the insoluble residue, after filtering the solution of the fusion mixture in water, for testing in accordance with Section 37.

SULFUR AS BARIUM SULFATE

Sulfur as Barium Sulfate.

37. The barium sulfate is calculated from the barium in the ash, which is determined as follows: Filter off the insoluble matter after the fusion and extraction described in Section 36, wash back into the original beaker with hot water, dissolve the residue in the beaker and any traces on the filter paper with HCl, and heat the solution on the steam bath. Filter through the same filter as before and wash thoroughly with hot water. Nearly neutralize the solution with NH_4OH, leaving it slightly acid. Saturate the cold solution with H_2S, and when the lead sulfide has settled, filter into a 400-cc. beaker and wash thoroughly. The total volume should be not over 200 cc. Precipitate with H_2SO_4 (10-per-cent) and determine the sulfur in the

usual manner. Barium sulfate determined above is assumed to have been added as such. Obviously, if barium carbonate is present, it must be determined in order that an undue correction will not be made.

$$\text{Percentage of sulfur as barium sulfate} = \frac{\text{Wt. of } BaSO_4 \times 0.1373}{\text{Wt. of sample}} \times 100$$

TOTAL ANTIMONY

Total Antimony.

38. When a qualitative test indicates that antimony is present, weigh out a 0.5-g. sample, and transfer to a Kjeldahl flask, add 25 cc. of concentrated H_2SO_4 and 10 to 12 g. of potassium sulfate, place a funnel in the neck of the flask, and heat until the solution becomes colorless. Cool and wash the funnel, dilute the solution to 100 cc. with water, and transfer to a 400-cc. beaker, dilute to 250 cc. with hot water, and precipitate the antimony with H_2S. Filter and transfer the precipitate to a Kjeldahl flask, add 15 cc. of concentrated H_2SO_4, 10 to 12 g. of potassium sulfate, and heat as described above until the solution is colorless. Wash the funnel, dilute the solution to 100 cc. with water, add 1 to 2 g. of sodium sulfite, and boil until all the sulfur dioxide is driven out.

This is shown when no blue color is obtained with starch iodate paper. Add 20 cc. of concentrated HCl, dilute to 250 to 275 cc. with water, cool to 10 to 15° C., and titrate with standard 0.1 *N* permanganate solution until a faint pink color is obtained. If iron is found to be absent it is not necessary to precipitate the antimony with H_2S and the second heating in a Kjeldahl flask may be eliminated.

$$\text{Percentage of antimony} = \frac{\text{Sb (see Section 18 } (f)) \times \text{cubic centimeters of permanganate}}{\text{Wt. of sample}} \times 100$$

ANTIMONY IN THE ASH

Antimony in the Ash.

39. Antimony in the ash is determined on the ash of a 1-g. sample as follows: Transfer the ash to a 600-cc. Erlenmeyer flask, add 12 to 15 cc. of concentrated H_2SO_4 and 10 to 12 g. of potassium sulfate, and boil until solution is complete. It may be necessary to warm part of the H_2SO_4 in the crucible to transfer any adhering particles to the flask. Rinse with the remaining portion of acid. Then complete the determination as described in Section 38.

$$\text{Percentage of antimony as } Sb_2O_4 \text{ in ash} = \frac{\text{Sb (see Section 18 } (f)) \times \text{cubic centimeters of permanganate} \times 1.26}{\text{Wt. of sample}} \times 100$$

FREE CARBON

Free Carbon.

40. Extract a 0.5-g. sample for 8 hours with a mixture of 68 per cent chloroform and 32 per cent acetone by volume.

Transfer the sample to a 250-cc. beaker and heat on the steam bath until it no longer smells of chloroform. Add a few cubic centimeters of concentrated HNO_3 and allow to stand for about 10 minutes. Add 50 cc. more of concentrated HNO_3, taking care to wash down the sides of the beaker, and heat on the steam bath for at least 1 hour. At the end of this time there should be no more bubbles or foam on the surface. Pour the liquid while hot into a Gooch crucible, taking care to keep as much as possible of the insoluble material in the beaker. Filter slowly with gentle suction and wash well by decantation with hot concentrated HNO_3. Wash with acetone and a mixture of equal parts of acetone and chloroform until the filtrate is colorless. Digest the insoluble material, which has been carefully retained in the beaker, for 30 minutes on the steam bath with 35 cc. of sodium hydroxide solution (25-per-cent). This treatment with alkali may be omitted if silicates are absent. Dilute to 60 cc. with hot distilled water and heat on the steam bath. Filter the solution of alkali and wash well with hot sodium hydroxide solution (15-per-cent).

Next, wash the residue about four times with hot concentrated HCl. Neutralize the last washing with NH_4OH and test for the presence of lead with sodium chromate solution. If lead is present continue to wash with hot concentrated HCl and, finally, wash with warm HCl (5-per-cent). Remove the crucible from the funnel, taking care that the outside is perfectly clean, dry it in an air bath for $1\frac{1}{2}$ hours at 110° C., cool, weigh, burn off the carbon at a dull red heat, and reweigh. The difference in weight represents approximately 105 per cent of the carbon originally present in the form of lampblack or gas black.

$$\text{Percentage of free carbon} = \frac{\begin{matrix}\text{Wt. of crucible} \\ \text{with carbon}\end{matrix} - \begin{matrix}\text{wt. of crucible} \\ \text{after ignition}\end{matrix}}{1.05 \times \text{Wt. of sample}} \times 100$$

NITROGEN CALCULATED AS GLUE

Nitrogen Calculated as Glue.

41. When glue is found to be present, a correction must be made for the natural protein in the rubber. The average amount of nitrogen is 0.4 per cent. See Section 49 for calculations.

Extract a 2-g. sample for 8 hours with acetone. Remove the solvent from the sample, and transfer the latter from the filter paper to a 750-cc. Kjeldahl flask. Add 25 to 30 cc. of concentrated H_2SO_4, 10 to 12 g. of sodium sulfate, and about 1 g. of copper sulfate. Heat gently until the first vigorous frothing ceases, then raise the heat gradually until the liquid boils. Continue the boiling until the solution becomes clear. Allow the flask to cool, dilute carefully with 150 cc. of water, and again allow to cool. Add 100 cc. of sodium hydroxide solution (50-per-cent), pouring it carefully down the side of the flask, so that it does not mix immediately with the acid solution. Add about 1 g. of granulated zinc to prevent bumping and a piece of paraffin the size of a pea to diminish frothing. Connect the flask quickly with a condenser, the delivery tube of which dips into a 500-cc. Erlenmeyer flask, containing 50-cc. of 0.1 *N* H_2SO_4 diluted to about 100 cc. Carefully swirl the flask to mix the contents and start to heat gently, increase the flame as the danger of foaming over diminishes, and finally boil briskly until about one-half of the liquid has passed over into the receiver. Add methyl red solution and titrate the excess acid by means of 0.1 *N* NaOH solution. A blank determination should be made.

$$\text{Percentage of nitrogen as glue} = \frac{\begin{array}{c}100\ (H_2SO_4 \times \text{normality} - \text{NaOH} \times \text{normality})\\ (0.014)\ (6.5)\end{array}}{\text{Wt. of sample}}$$

When a 2-g. sample is used this formula becomes:

$$\text{Percentage of nitrogen as glue} = (H_2SO_4 \times \text{normality} - \text{NaOH} \times \text{normality}) \times 4.55$$

UNSAPONIFIABLE MATTER

Unsaponifiable Matter.

42. If this determination is made the free sulfur shall be determined on a separate 2-g. sample.

Add to the acetone extract obtained from two 2-g. samples (see Section 29), 50 cc. of *N* alcoholic-potash solution, heat on the steam bath under a reflux condenser for 2 hours, remove the condenser and evaporate to dryness. Transfer to a separatory funnel, using about 100 cc. of water, add 25 cc. of ether, and shake. Allow the two layers to separate thoroughly, then draw off the water layer. Continue the extraction of the water layer with fresh portions of ether until no more unsaponifiable matter is removed, unite the ether layers, and wash with distilled water. Transfer the ether to a weighed flask, distill off the ether, dry to constant weight at 70° C., cool, and weigh.

$$\text{Percentage of unsaponifiable matter} = \frac{\text{Wt. of extract}}{\text{Wt. of sample}} \times 100$$

HYDROCARBONS *A*

43. To the unsaponifiable matter (see Section 42), add 50 cc. of absolute alcohol, and heat on the steam bath for 30 minutes. Let the flask stand in a mixture of ice and salt for 1 hour. Filter off the separated waxy hydrocarbons on filter paper, by applying a gentle suction. Wash with alcohol (95-per-cent) which has been cooled in an ice-salt mixture. The funnel should be surrounded by a freezing mixture. **Hydrocarbons A.**

Dissolve the precipitate from the filter paper with hot chloroform, and catch the solution in a weighed 100 to 150-cc. beaker. Wash the flask with hot chloroform which is added to the same beaker, in order to include any insoluble matter adhering to the walls of the flask. Evaporate off the solvent, dry to constant weight at 70° C., cool, and weigh.

$$\text{Percentage of hydrocarbons } A = \frac{\text{Wt. of extract}}{\text{Wt. of sample}} \times 100$$

HYDROCARBONS *B*

44. Evaporate the alcohol from the flask containing the alcohol soluble unsaponifiable material, add 25 cc. of carbon tetrachloride, and transfer to a separatory funnel. Shake with concentrated H_2SO_4, drain off the discolored acid, and repeat with fresh portions of acid until there is no longer any discoloration. After drawing off all the acid, wash the carbon tetrachloride solution with repeated portions of water until all traces of acid are removed. Transfer the carbon tetrachloride solution to a weighed flask, evaporate off the solvent, and dry to constant weight at 70° C., cool, and weigh. **Hydrocarbons B.**

$$\text{Percentage of hydrocarbons } B = \frac{\text{Wt. of extract}}{\text{Wt. of sample}} \times 100$$

RUBBER HYDROCARBONS

(JOINT RUBBER INSULATION COMMITTEE)

45. Add to the flask containing the rubber residue from the alcoholic-potash extraction sufficient water to make the total 125 cc. and then add 25 cc. of concentrated HCl. Heat for 1 hour at 100° C. Decant the supernatant liquid through a hardened filter paper on a Büchner funnel, 7 cm. in diameter, using suction. Wash the residue with 25 cc. of hot water and decant. (Although a Büchner funnel is recommended, it is permissible to use an 11-cm. hardened filter paper with platinum cone in a 60-deg. funnel.) Perform this entire **Joint Rubber Insulation Committee Procedure.**

treatment with water and HCl three times. The rubber at this stage should be white and practically free from black specks of undissolved fillers; if not, continue the acid treatment until the black specks disappear. (If carbon is present, all the particles of rubber will be grayish, bluish, or black, depending on the form and quantity of carbon used. Black specks in light particles of rubber usually indicate the presence of lead sulfide which must be removed to prevent the formation of lead sulfate on igniting the residue *C*.) Add 150 cc. of hot water to the flask and allow to stand on a steam bath or hot plate for 30 minutes and decant through the filter paper, repeating until washings are free from chlorides. Transfer all the rubber in the flask to the filter paper and dry as much as possible by suction. Wash the rubber with 50 cc. of alcohol (95-per-cent), using suction. Transfer the entire residue to a weighing bottle. Dry at 95 to 100° C. for 1 hour, cool in a vacuum desiccator under reduced pressure and weigh. Dry for 30 minutes, cool, and weigh, repeating this process until either constant weight is reached or the weight starts to increase. Let this weight be represented by *C*. The weight originally taken for the acetone extract determination shall be called *A*. Determine the ash (*E*) on a portion (*D*) of this residue (*C*), and sulfur (*H*) on the remaining portion (*G*). Also determine the sulfur (*F*) on the ash (*E*). Perform the ash determination as described in Section 35, and the sulfur determination as described in Section 33.

$$\text{Percentage of rubber hydrocarbons} = 100\,\frac{C}{A}\left(1-\frac{H}{G}-\frac{E-F}{D}\right)$$

CELLULOSE

Cellulose. 46. (*a*) Treat 0.5 g. of rubber previously extracted with a constant boiling mixture of acetone and chloroform with 25 cc. of rubber solvent oil (see Section 18 (*h*)), in a 250-cc. lipped assay flask. Place in an air bath at a temperature of 145 to 150° C. until small particles can be seen distinctly in the supernatant liquid, which requires about 3 hours. Dilute with 15 cc. of benzene and 200 cc. of petroleum ether. Filter through a Gooch crucible and wash the residue thoroughly with warm acetone. Treat repeatedly with hot HCl (10-per-cent) until the residue is free from acid-soluble fillers. Wash the pad well with boiling water, and run small portions of acetone through it until the filtrate is colorless. Wash with alcohol and dry at 105° C. to constant weight. Remove the pad from the crucible with the help of a pair of sharp-pointed tweezers, using the under portion of the pad as a swab to clean the sides of the crucible, and place all of this material in a tared weighing bottle. Replace in the drying oven for about 10 minutes, cool and weigh.

Weight of weighing bottle, pad, insoluble fillers, and cellulose minus weight of the weighing bottle equals weight of pad, insoluble fillers, and cellulose.

(*b*) Transfer the contents of the weighing bottle to a 50-cc. beaker and pour over it 15 cc. of acetic anhydride and 0.5 cc. of concentrated HS_2O_4, and allow to digest for at least 1 hour, on the steam bath. After the mixture has cooled thoroughly, dilute with 25 cc. of acetic acid (90-per-cent), and filter through a weighed Gooch crucible. To guard against traces of the material being carried through, this filtration, as well as the ones to follow, must be very slow and only gentle suction can be used. Wash with hot acetic acid (90-per-cent), until the filtrate comes through absolutely colorless and then wash about four times more. Wash with acetone about five times. After having taken care that all of the material has been washed out of the beaker in which the acetylation took place, remove the crucible from the funnel, clean the outside thoroughly, and dry for 2 hours at 150° C. Cool and weigh. The original weight of the crucible plus weight of pad, fillers, and cellulose minus the weight of the crucible after acetylation equals cellulose.

$$\text{Percentage of cellulose} = \frac{\text{Cellulose}}{\text{Wt. of sample}} \times 100$$

BARIUM CARBONATE

Barium Carbonate.

47. Bartyes was determined by the calculation to barytes of all barium found in the sample. Obviously, if barium carbonate is present, it must be determined in order that an undue correction will not be made. The determination is as follows: A 1-g. sample, in a porcelain boat, is placed in a combustion tube through which passes a current of carbon dioxide. The sample is ashed in the tube. After ignition and cooling, in the atmosphere of carbon dioxide, the boat is removed, the residue finely ground in an agate mortar, transferred to a 250-cc. beaker, and treated with 5 to 10 g. of ammonium carbonate, 15 to 20 cc. of strong ammonia water, and about 50 cc. of distilled water. The mixture is boiled for 20 minutes, filtered, and the precipitate thoroughly washed to remove all soluble sulfates. The residue on the filter paper is washed back into the original beaker and about 10 cc. of glacial acetic acid with sufficient water to make the total volume about 100 cc. is added. This is heated to boiling and filtered through the same paper as before. Hydrogen sulfide is passed into

the filtrate to precipitate the lead and the solution is subsequently treated as in the determination of barytes. The final weight of barium sulfate obtained is calculated to barium carbonate.

$$\frac{\text{Percentage of sulfur required to convert}}{\text{barium present as carbonate to sulfate}} = \frac{\text{Wt. of } BaSO_4 \times 0.1373}{\text{Wt. of sample}} \times 100$$

The Rubber Solvent Method described in Sections 57 to 60, inclusive, has been found to be more rapid in the determination of barium carbonate, and as accurate as the above method.

CALCULATIONS

Acetone Extract. 48. Percentage of acetone extract corrected, equals percentage of acetone extract, uncorrected, minus percentage of free sulfur, and percentage of waxy hydrocarbons. The percentage of waxy hydrocarbons equals percentage of hydrocarbons *A* plus percentage of hydrocarbons *B*.

Glue. 49. Multiply the percentage of rubber as compounded by 0.004 and 6.5 and call this value *A*. Subtract *A* from the percentage of glue and call this value *B*. Substitute *B* for glue in calculating the percentage of rubber hydrocarbons and then complete the calculations.

Sulfur as Antimony Trisulfide. 50. Percentage of sulfur as antimony trisulfide equals percentage of total antimony multiplied by $\frac{S_3}{Sb_2}$ equals percentage of total antimony multiplied by 0.400.

Antimony as Trisulfide. 51. Percentage of total antimony as trisulfide equals percentage of total antimony multiplied by $\frac{Sb_2S_3}{Sb_2}$ equals percentage of total antimony multiplied by 1.400.

Total Sulfur, Corrected. 52. Percentage of total sulfur corrected equals percentage of total sulfur minus percentage of sulfur as barium sulfate minus percentage of sulfur as antimony trisulfide. When barium carbonate is found, the percentage of sulfur necessary to convert it to sulfate must be added to the total sulfur, corrected.

Ash Corrected. 53. Percentage of ash corrected equals percentage of ash minus percentage of sulfur in ash plus percentage of sulfur as barium sulfate minus percentage of antimony in ash, calculated to Sb_2O_4.

Rubber Hydrocarbon. 54. Percentage of rubber hydrocarbon equals 100 minus the sum of the following percentages, except when it is determined by the Joint Rubber Insulation Committee's Procedure:

Acetone extract, corrected.
Chloroform extract.
Alcoholic-potash extract.
Total sulfur, corrected.
Ash, corrected.
Carbon.
Glue.
Total antimony as trisulfide.

Rubber as Compounded

55. The percentage of rubber hydrocarbon plus 5 per cent of its weight is taken as "rubber as compounded," except when the sum of the percentages of the acetone extract corrected, chloroform extract, and alcoholic-potash extract is less than the figure represented by the arbitrary 5 per cent, as in many high-grade compounds. Percentage of rubber as compounded is then equal to the percentage of rubber hydrocarbon plus the sum of the percentages of the acetone extract corrected, the chloroform extract, and the alcoholic-potash extract.

$$\text{Percentage of rubber by volume} = \frac{\text{Percentage of rubber as compounded} \times \text{sp. gr. of compound}}{\text{0.94 (taken as the average sp. gr. of crude rubber)}}$$

$$\text{Ratio of acetone extract corrected} = \frac{\text{Percentage of acetone extract corrected}}{\text{Percentage of rubber as compounded}} \times 100$$

$$\text{Ratio of sulfur to rubber} = \frac{\text{Percentage of total sulfur, corrected}}{\text{Percentage of rubber as compounded}} \times 100$$

REPORT

Report.

56. The report shall include the following:

(*a*) Percentage of acetone extract, corrected;
(*b*) Percentage of waxy hydrocarbons;
(*c*) Percentage of chloroform extract;
(*d*) Percentage of alcoholic-potash extract;
(*e*) Percentage of free sulfur;
(*f*) Percentage of total sulfur, corrected;
(*g*) Percentage of ash, corrected;
(*h*) Percentage of cellulose;
(*i*) Percentage of sulfur as barium sulfate;
(*j*) Percentage of total antimony;
(*k*) Percentage of sulfur as antimony trisulfide;
(*l*) Percentage of carbon;
(*m*) Percentage of glue;
(*n*) Percentage of rubber hydrocarbon;
(*o*) Percentage of rubber, as compounded;
(*p*) Percentage of rubber by volume;
(*q*) Ratio of acetone extract to rubber as compounded;
(*r*) Ratio of sulfur to rubber as compounded;
(*s*) Specific gravity.

RUBBER SOLVENT METHOD

Rubber Solvent Method.

57. Weigh two portions "*a*" and "*b*" of from 0.5 to 1 g. each of the finely-ground sample. Extract with a mixture of 32 per cent of

acetone and 68 per cent of chloroform by volume for a minimum of 8 hours.[1] If the liquid in the extraction apparatus is still colored at the end of this time, the extraction should be continued. Remove the samples and put each into a 150-cc. lipped assay flask, add 20 to 25 cc. of the oil, cover with a watch glass and heat in an air bath at a temperature of 150 to 155° C. until solution appears complete and then 15 to 30 minutes more. Solution may be considered complete when the rubber colloid has been broken down and the oil seems quite clear. Remove the flasks from the air bath, cool to about 110° C., and add in a small stream 10 to 15 cc. of benzene, while mixing thoroughly; allow to cool and then dilute with sufficient petroleum ether to fill each flask to within about 2 cm. of the top. Mix thoroughly, cover the flasks to prevent evaporation and allow the mixture to stand overnight.

A. *Treatment of Portion "a."*

Procedure for Portion "a."

58. (*a*) Prepare a Gooch crucible with finely divided asbestos that has been previously treated with strong caustic soda solution and concentrated HCl and washed well with water. Ignite the crucible, cool and weigh; call this weight *c*. Filter the mixture by decantation through the crucible, using suction; wash well with petroleum ether, followed by warm acetone, and by a warm mixture of equal volumes of acetone and chloroform if the filtrate is dark. Remove as much as possible of the organic residue by washing; finally, wash with hot alcohol. A portion of the fillers will remain in the flask. Dry the crucible and flask with their contents for 1 hour at a temperature of 105 to 110° C. Cool and weigh. Call the weight of the flask and contents *d* and the weight of the crucible and contents *e*.

(*b*) Remove the acid-soluble compounding ingredients from the flask and Gooch crucible, collecting the solution in a 400-cc. beaker, by adding to the flask and crucible a few cubic centimeters of boiling alcohol. Allow to soak for 2 or 3 minutes and then wash two or three times with boiling water; let the flask cool, add 10 cc. of concentrated HCl and swirl the flask to bring the acid in contact with the compounding ingredients. Pour the acid from the flask into the crucible and let it stand until no more bubbles rise through the liquid. If carbonates are present, there is danger of loss by excessive frothing. This can be prevented by first adding a few drops of the acid to the crucible and sucking it through the pad. After the violent action has ceased, the remainder of the 10 cc. of acid is added. When no more gas is evolved, draw the acid through the pad and again wash with 20 cc. of acid, adding a little at a time. Wash well with hot water, and transfer as much as possible of the residue remaining in the flask to the asbestos pad. If by qualitative tests the sample was found to contain antimony, save the filtrate and washings for treatment as described in Paragraph (*c*). Dry the flask and crucible for 1 hour at 105 to 110° C., cool and weigh. Call the weight of the flask f, and that of the crucible containing the organic residue and acid-insoluble fillers, h. Burn the organic residue from the asbestos pad by igniting in a furnace at a temperature of 700° C., cool and weigh. Call this weight k. If the sample contains barytes, save the contents of the crucibles for treatment as described in Paragraph (*d*).

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[1] U. S. Bureau of Standards *Technologic Paper No. 162;* also *Rubber Age and Tire News*, pp. 445-447 (1920).

(*c*) *Determination of Sulfur Present as Antimony Trisulfide.*[1]—Dilute the filtrate in the beaker (see Paragraph (*b*)) to about 250 cc. and precipitate the antimony with H_2S. Filter off the antimony sulfide and wash the precipitate with H_2S water to which a little HCl has been added. Transfer the filter paper containing the antimony precipitate to a Kjeldahl flask, and add 12 cc. of concentrated H_2SO_4 and 5 g. of potassium sulfate. Heat the solution gently until it is colorless, dilute to 100 cc. and add 1 to 2 g. of sodium sulfite. Boil until the sulfur dioxide is driven out. Dilute to 250 to 275 cc., cool to 10 to 15° C., and titrate with standard permanganate solution. Calculate the antimony present to antimony trisulfide and express the sulfur present as antimony trisulfide in percentage of the sample and call this L.

(*d*) *Determination of Barytes.*—Transfer the contents of the crucible (see Paragraph (*c*)) to a 50-cc. porcelain crucible and fuse with 5 g. of a mixture of equal weights of sodium carbonate and nitrate. Stir well during the fusion. Cool the crucible, put it into a 250-cc. beaker, cover with distilled water and heat on the steam bath until all the solid material has been loosened from the crucible. Filter and wash the residue with warm water to free from sulfate. Wash the residue back into the beaker and dissolve in HCl (10-per-cent), using about 10 cc. excess and keeping the solution warm. Filter off the asbestos, wash well with hot water, and precipitate the barium in the solution with 10 cc. of H_2SO_4 (10-per-cent). Heat on the steam bath, filter off the precipitate, ignite and weigh the barium sulfate.

$$\text{Percentage of sulfur present as barytes} = m = \frac{100 \times \text{wt. of } BaSO_4 \times 0.1373}{\text{Wt. of sample "}a\text{"}}$$

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[1] S. Collier, M. Levin, and J. A. Scherrer, "Determination of Antimony in Rubber Goods," *India Rubber World* 64, p. 580 (1921).

B. Treatment of Portion "b" for Sulfur in Compounding Ingredients:

Procedure for Portion "b."

59. Treat portion "*b*" as described in Section 58(*a*), but omit the weighing of the crucible. After the pad has been dried, transfer it to the flask. The last traces of the fillers can be removed from the sides of the crucible with wads of absorbent cotton moistened with a little warm water. Add to the fillers about 10 cc. of bromine water, and swirl the flask to moisten the contents. Add 20 cc. of concentrated HNO_3 saturated with bromine. Allow to stand for 15 minutes and then heat on the steam bath for 1 hour. Transfer the contents of the flask to a 75-cc. crucible and evaporate to dryness. Complete the determination of sulfur by the method described in Section 33. Let the value for the percentage of sulfur in compounding ingredients be represented by *n*.

Calculations.

60. (*a*) *Calculations.*—The percentage of total inorganic compounding ingredients, corrected, equals:

$$\frac{100\,(e + d + k) - (c + f + h)}{0.5} + (m + L) - n$$

(*b*) To determine the percentage of rubber hydrocarbon subtract from 100 the sum of the percentages of acetone, chloroform, and alcoholic potash extracts, free carbon, glue, total sulfur corrected, and total inorganic compounding ingredients corrected.

TENTATIVE METHOD OF TEST
FOR
HARDNESS OF SOFT RUBBER (IN SLAB FORM)[1]

A.S.T.M. Designation: D 314 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Hardness of Soft Rubber. 1. For the purpose of this test, hardness of soft rubber shall be considered as that property by virtue of which the surface and adjoining layers of the material resist indentation by a spherical penetrator of standard size under a definite pressure.

APPARATUS

Table. 2. A flat horizontal table having a minimum linear dimension in the horizontal plane of 2 in. shall be used to support the test specimen.

Penetrator. 3. (*a*) The penetrator shall consist of a truly hemispherical point $\frac{3}{32}$ in. ± 0.0005 in. in diameter located at the lower end of a rigid, vertical shaft. The shaft shall have a maximum diameter not exceeding that of the ball point for that portion of its length that passes through the pressure foot described in Section 4. The penetrator shall be made of a non-corrosive, hard metal properly treated to resist wear due to continuous use. The spherical point shall be highly polished.

(*b*) The penetrator shall be actuated by a freely-acting load of 3 lb. ± 0.25 oz. Less than 0.25 oz. shall produce perceptible motion of the penetrator when counter-balanced.

(*c*) The penetrator shall act through the opening in the center of the pressure foot.

Pressure Foot. 4. (*a*) The pressure foot shall be $\frac{5}{8}$ in. ± 0.005 in. in diameter and shall have a hole $\frac{7}{64}$ in. ± 0.005 in. in diameter located at the center. It shall be sufficiently thick to insure rigidity and the edges shall be rounded off with a maximum radius of $\frac{1}{64}$ in. The inner surface of the pressure foot shall be parallel to and concentric with the surface of the shaft of the penetrator. The faces of the pressure foot shall be at right angles to the inner surface.

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[1] Criticisms of this Tentative Method are solicited and should be directed to Mr. Arthur W. Carpenter, Secretary of Committee D-11 on Rubber Products, The B. F. Goodrich Co., Akron, Ohio.

(*b*) The pressure foot shall be subjected to a freely acting load of 5 lb. ± 0.75 oz.

Penetration Dial. 5. Vertical movement of the penetrator shall actuate a suitable dial gage graduated to show indentation in 0.001 in. The accuracy over the whole range shall be within ± 0.0005 in. penetration. The gage shall be mounted so as to be rigid with the pressure foot.

TEST SPECIMEN

Test Specimen. 6. The test specimen should preferably be at least $\frac{1}{2}$ in. thick with parallel sides (slab form). No other dimension of the test specimen shall be less than 1 in. greater than the diameter of the pressure foot. Satisfactory results may be secured using specimens having a thickness as low as $\frac{7}{32}$ in., but the results will be comparative only when secured from test specimens having essentially the same thickness.

PROCEDURE

Procedure. 7. (*a*) The pressure foot and penetrator shall be lowered until contact is made with the test specimen. The full load shall then immediately be allowed to act, without shock, on the penetrator. Readings on the penetration dial shall be made exactly 30 seconds after the full load is applied.

(*b*) The test specimen shall be shifted to a new position after each contact in order to avoid errors due to fatigue effects.

Number of Readings. 8. (*a*) *Routine Testing.*—When the apparatus is used for routine testing of rubber specimens, an average of at least five readings is advisable. All readings shall be considered except those known to be definitely in error for some reason. In repeatedly testing the same compound, satisfactory results may be obtained when readings are taken after a uniform smaller time interval than the 30 seconds specified. In all such cases, the time interval used shall be stated with the result.

(*b*) *Standard for Calibration.*—When the apparatus is used as a reference standard for the calibration of other types of hardness testers, uniform test specimens shall be employed. A minimum of five readings shall be made and their average taken as the hardness measurement excepting that no reading may differ by more than ±0.002 in. from the mean value.

TENTATIVE SPECIFICATIONS AND TEST METHODS
FOR
ASBESTOS TAPE FOR ELECTRICAL PURPOSES[1]

A.S.T.M. Designation: D 315 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

1. These specifications cover asbestos tape woven from plain asbestos yarn and suitable for electrical purposes. **Scope.**

COMPOSITION

2. The asbestos tape shall be woven from Grade *A* plain asbestos yarn containing 15 to 20 per cent of cotton, conforming to the Standard Specifications for Tolerances and Test Methods for Asbestos Yarns (A.S.T.M. Designation: D 299) of the American Society for Testing Materials.[2] **Cotton Content.**

TENSILE STRENGTH

3. The tensile strength of the tape per inch of width shall conform to the following minimum requirements: **Tensile Strength.**

THICKNESS, IN.	TENSILE STRENGTH, LB. PER IN. OF WIDTH
0 015	25
0.020	40
0.025	90
0.030	120

4. The tensile strength of the tape per inch of width after being heated in an oven for five minutes at 300° C. shall not be less than 50 per cent of the values specified in Section 3. **Tensile Strength After Heating.**

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. J. E. Skane, Secretary of Committee D-13 on Textile Materials, Manhattan Rubber Manufacturing Co., Passaic, N. J.

[2] 1929 Supplement to Book of A.S.T.M. Standards, p. 166.

Number of Tests. 5. The tensile strength tests before and after heating shall each be made on five specimens, none of which shall break below the minimum values specified in Sections 3 and 4.

CONSTRUCTION

Ends and Picks. 6. The number of ends and picks per inch shall conform to the following requirements within plus or minus 2 ends and plus or minus 1 pick:

Thickness, in.	Ends per inch	Picks per inch
0.015	30	18
0.020	21	18
0.025	27	12
0.030	27	12

Weave. 7. The tape shall be uniformly woven and shall have selvage edges.

Metallic Particles. 8. The tape shall be practically free from microscopic particles of iron.

THICKNESS

Thickness. 9. The thickness of the tape shall not vary more than plus or minus 0.003 in. from the specified thickness.

WIDTH

Width. 10. The width shall not vary from that specified more than plus or minus $\frac{1}{32}$ in. for tape up to and including 1 in. in width, and plus or minus $\frac{1}{16}$ in. for tape over 1 in. in width.

YARDAGE

Yardage. 11. The number of yards per pound shall conform to the following minimum requirements:

Width, in.	Thickness, in.	Yardage per pound
½	0.015	85
¾	0.015	65
1	0.015	55
1¼	0.015	40
1½	0.015	30
1	0.020	40
½	0.025	45
¾	0.025	35
1	0.025	25
1¼	0.025	18
1½	0.025	13
1¼	0.030	15

METHODS OF TESTING

COMPOSITION

Cotton Content Determination. 12. The cotton content and percentage of cellulose shall be determined in accordance with Sections 6 and 7 of the Standard Specifications for Tolerances and Test Methods for Asbestos Yarns (A.S.T.M. Designation: D 299) of the American Society for Testing Materials.[1]

TENSILE STRENGTH

Apparatus. 13. (*a*) The tensile strength shall be determined on a testing machine conforming to the requirements of the Standard Specifications for Textile Testing Machines (A.S.T.M. Designation: D 76) of the American Society for Testing Materials.[2]

Procedure. (*b*) Tensile strength tests shall only be made in the direction of the warp. The specimens shall be tested in full section. The initial length of the test specimens between the jaws shall be 3 in. and the speed of the pulling jaw shall be 12 in. per minute.

CONSTRUCTION

Ends and Picks. 14. (*a*) The number of ends and the number of picks shall be taken as the average of five counts in five different places on the sample.

(*b*) The total number of ends shall be determined regardless of the width of the tape.

(*c*) The number of picks shall be determined in a length of 1 in.

THICKNESS

Method of Measuring Thickness. 15. The thickness shall be determined by a micrometer having measuring faces not less than $\frac{7}{16}$ in. nor more than $\frac{1}{2}$ in. in diameter. Readings shall be made while the micrometer faces hold the tape with just sufficient pressure to permit the tape to be moved without distorting the threads.

Number of Measurements. 16. The thickness shall be taken as the average of ten measurements at ten different places on the sample.

WIDTH

Method of Measuring Width. 17. The width shall be determined by the use of a standard steel scale graduated to within the degree of accuracy specified in Section 10. The determination shall be made with the material laid flat on a smooth surface.

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[1] 1929 Supplement to Book of A.S.T.M. Standards, p. 166.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 867.

Number of Measurements. 18. The width shall be taken as the average of ten measurements at ten different places on the sample.

YARDAGE

Method of Measuring Yardage. 19. The yardage shall be determined by accurately measuring a sample not less than 12 yards in length and weighing it on a balance sensitive to 0.5 per cent of the weight of the specimen. The length determination shall be made with the material laid flat on a smooth surface and held taut without stretching.

WORKMANSHIP AND FINISH

Workmanship. 20. The workmanship shall be first class as shown by even spacing in the weave, freedom from nap and from broken threads, uneven threads, and knots.

Finish. 21. The tape shall be calendered, but the calendering shall not be so heavy as materially to reduce the strength.

Sizing. 22. No sizing shall be used.

PACKING

Rolls. 23. (*a*) The tape shall be wound in continuous rolls on bushings having a length $\frac{1}{16}$ in. shorter than the width of the tape and an inside diameter of $\frac{3}{8}$ in. or $\frac{1}{2}$ in. as specified by the purchaser. The bushings shall have sufficient strength to resist crushing in packing and shipment.

(*b*) The rolls shall each contain 36 yd. of tape.

(*c*) The end of the tape shall be secured with a gummed label.

TENTATIVE SPECIFICATIONS
FOR
CHAFER TIRE FABRICS[1]

A.S.T.M. Designation: D 316 - 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

ISSUED, 1929.

Scope.

1. These specifications cover commercial 8, 9, 12 and 14-oz. chafer tire fabrics made of carded American cotton, of the following constructions:

8 oz.	20/3 ply (in both warp and filling)....	1 to $1\frac{1}{16}$-in. staple commercial cotton
	14/2 ply (" " " " ")....	$\frac{15}{16}$ to 1-in. " " "
9 oz.	20/4 ply (" " " " ")....	1 to $1\frac{1}{16}$-in. " " "
	10/2 ply (" " " " ")....	$\frac{15}{16}$ to 1-in. " " "
12 oz.	12/4 ply (" " " " ")....	$\frac{15}{16}$ to 1-in. " " "
14 oz.	20/8 ply (" " " " ")....	1 to $1\frac{1}{16}$-in. " " "
	10/4 ply (" " " " ")....	$\frac{15}{16}$ to 1-in. " " "

Properties.

2. Chafer tire fabric shall conform to the requirements specified in Table I, subject to the tolerances specified in Sections 1 to 9 of the Standard Specifications for Tolerances and Test Methods for Tire Fabrics Other than Cord Fabrics (A.S.T.M. Designation: D 122) of the American Society for Testing Materials.[2]

Methods of Testing.

3. With the exception of the tensile strength determination, all test procedures shall be conducted in accordance with Sections 10 to 16 of the Standard Specifications for Tolerances and Test Methods for Tire Fabrics Other than Cord Fabrics (A.S.T.M. Designation: D 122) of the American Society for Testing Materials.[2] The tensile strength shall be determined by the Grab Test in accordance with

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[1] Criticisms of these Tentative Specifications are solicited and should be directed to Mr. J. E. Skane, Secretary of Committee D-13 on Textile Materials, Manhattan Rubber Manufacturing Co., Passaic, N. J.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 884.

Sections 11 and 12 of the Standard General Methods of Testing Woven Textile Fabrics (A.S.T.M. Designation: D 39)[1] and the speed of the pulling jaw shall be 12 in. per minute.

TABLE I.—PHYSICAL PROPERTIES OF CHAFER TIRE FABRICS.

		8-oz. Fabric		9-oz. Fabric		12-oz. Fabric	14-oz. Fabric	
		20/3 Ply Construction	14/2 Ply Construction	20/4 Ply Construction	10/2 Ply Construction	12/4 Ply Construction	20/8 Ply Construction	10/4 Ply Construction
Width, in.		48, 54 or 60	48, 54 or 60	48, 54 or 60	48, 54 or 60	48, 54 or 60	48, 54 or 60	48, 54 or 60
Weight, oz. per sq. yd.		8.1	8.1	9.25	9.25	12.0	14.30	14.30
Count	Warp	35	37	29	29	22.5	22.5	22.5
	Filling	37	39	31	31	23.5	23.5	23.5
Thickness (Gage), in.		0.023	0.023	0.0275	0.0275	0.033	0.038	0.038
Tensile Strength,[a] lb. Grab Test, Conditioned[b]	Warp	110	105	130	120	155	200	185
	Filling	120	115	140	130	165	210	195
Tensile Strength,[a] lb. Grab Test, Bone dry[c]	Warp	80	75	85	80	105	135	120
	Filling	85	80	95	90	115	145	130
Ply Twist	Warp	11.0	11.0	7.5	8.5	6.5	5.0	5.5
	Filling	11.0	11.0	7.5	8.5	6.5	5.0	5.5
Crimp, per cent	Warp	16	16	16	16	16	16	16
	Filling	8	8	8	8	8	8	8

[a] Values of tensile strength are the minimum average.
[b] Preferred Method.
[c] Alternate Method.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 900.

TENTATIVE METHODS FOR IDENTIFICATION OF TEXTILE FIBERS AND THEIR QUANTITATIVE DETERMINATION IN MIXED GOODS[1]

A.S.T.M. Designation: D 276 – 29 T

This is a **Tentative Standard,** published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

Issued, 1927; Revised, 1929.

General Characteristics and Appearance of the Most Important Textile Fibers

Cotton:

Cotton, including several different kinds, consists of seed hairs obtained from different species of plants of the genus *Gossypium.* The kinds most used are American Upland cotton from *Gossypium hirsutum,* Sea Island from *Gossypium barbadense,* Egyptian supposed to be from a hybrid derived in part from *Gossypium barbadense,* India cotton from *Gossypium herbaceum* and Chinese cotton from *Gossypium nanking.*

Normal cotton fibers appear as long, colorless, twisted, ribbon-like cellular structures with thickened edges, due to the collapse of the original hollow cylindrical structure or tube. Most fibers have a flattened central air-filled canal or lumen. The length of the fibers varies with the variety from about ½ to 2 in. and the diameter or ribbon width from about 0.00063 to 0.00090 in The number of natural twists or convolutions along the fibers varies considerably, ranging from about 159 to 225 per in. These twists occur in both directions.

Flax or Linen:

Flax fibers are bast fibers from the inner bark of the flax plant, *Linum usitatisaimum.*

Flax fibers consist of groups of cells, and these ultimate cells are long pointed, colorless and fairly uniform in structure. The central lumen often indistinct and sometimes appearing double, is narrow compared with the thickness of the cell wall.

Characteristic slight swellings or nodes are to be found at fairly regular intervals, with fine almost invisible cross-lines. The nodes, discolorations and cross-lines are more pronounced in woven fabrics than in raw flax, and recent studies indicate that the cross-lines which have been regarded as especially characteristic of flax, seem to be produced chiefly by the methods of extracting and cleaning the fiber.

Individual flax fibers vary in diameter, from coarse or fine stemmed plants and also depending on how much it has been combed or split up.

Commercial flax usually runs about 20 in. in length, but some fibers may run up to 36 in. or even longer. The ultimate cells of flax range from 15 to 50 mm. (0.6 to 2.0 in.) but in actual practice the fibers are rarely, if ever, reduced to their ultimate cells. In woven fabrics, linen yarns often show a characteristic abrupt change in diameter due to fibers being partly split off in hackling. In contrast to this, cotton yarns vary in size in a tapering manner.

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[1] Criticisms of these Tentative Methods are solicited and should be directed to Mr. J. E. Skane, Secretary of Committee D-13 on Textile Materials, Manhattan Rubber Manufacturing Co., Passaic, N. J.

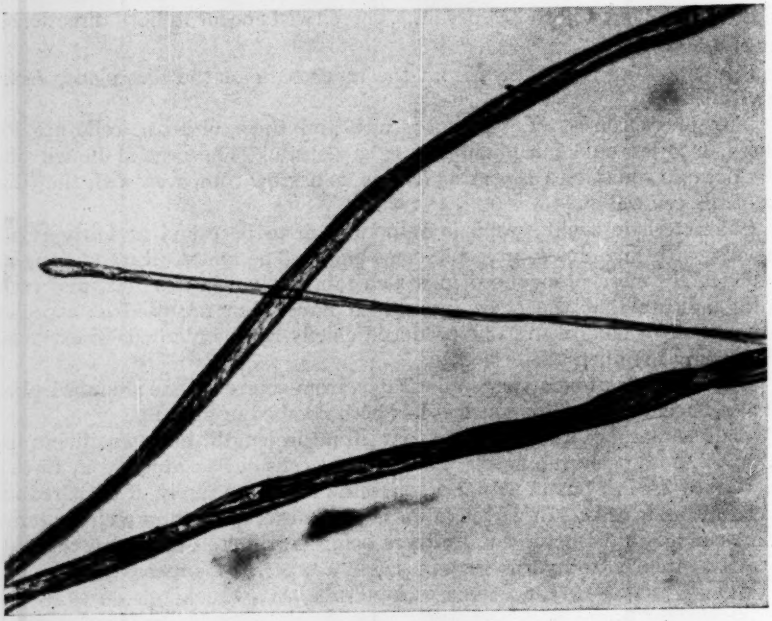

FIG. 1.—Longitudinal View of Cotton (× 250).

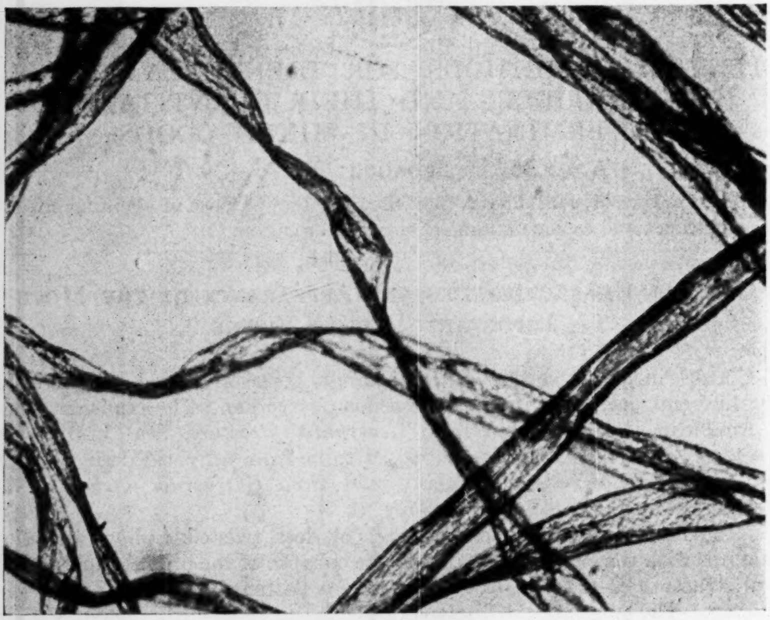

FIG. 2.—Longitudinal View of Immature Cotton (× 500).

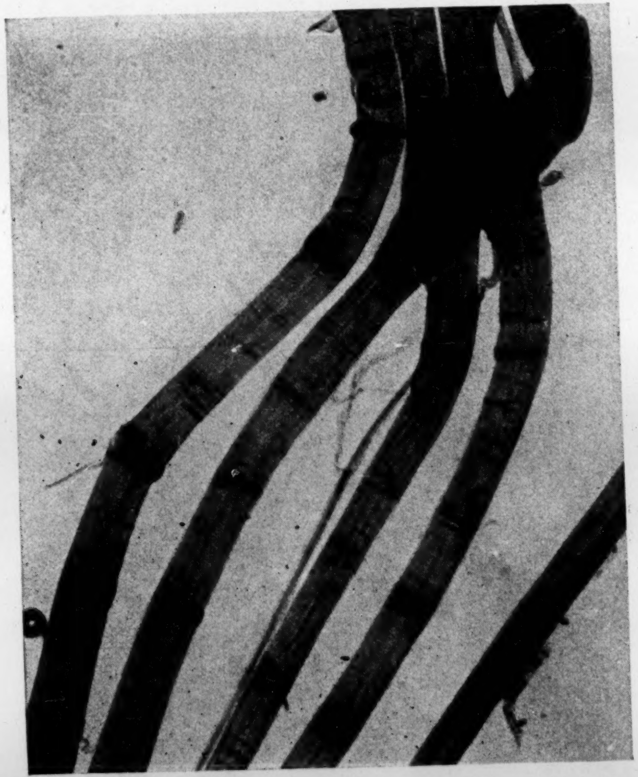

FIG. 3.—Longitudinal View of Flax or Linen Fibers (× 220).

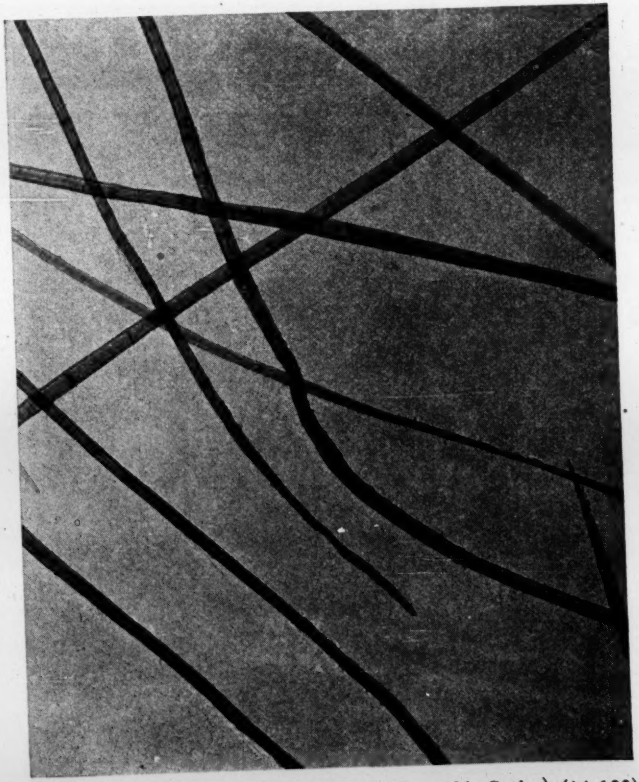

FIG. 4.—Longitudinal View of Hemp (*Cannabis Sativa*) (× 100).

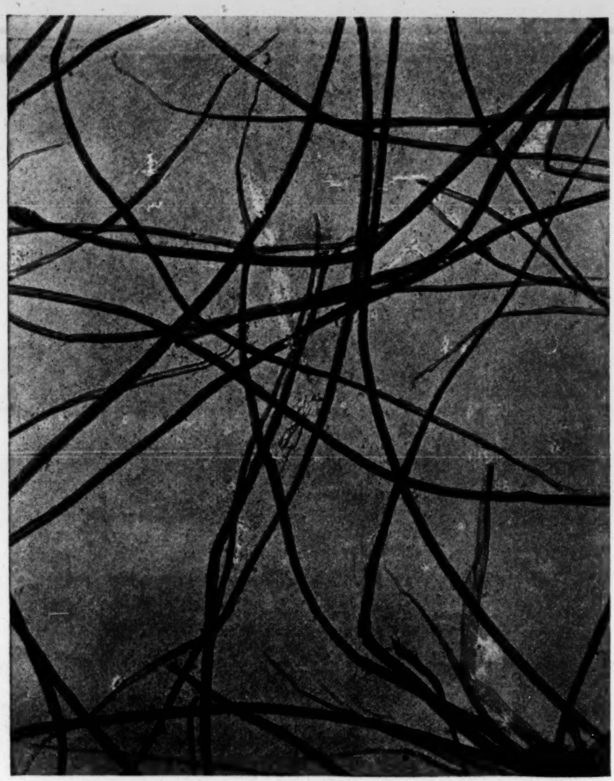

FIG. 5.—Longitudinal View of Jute (× 100).

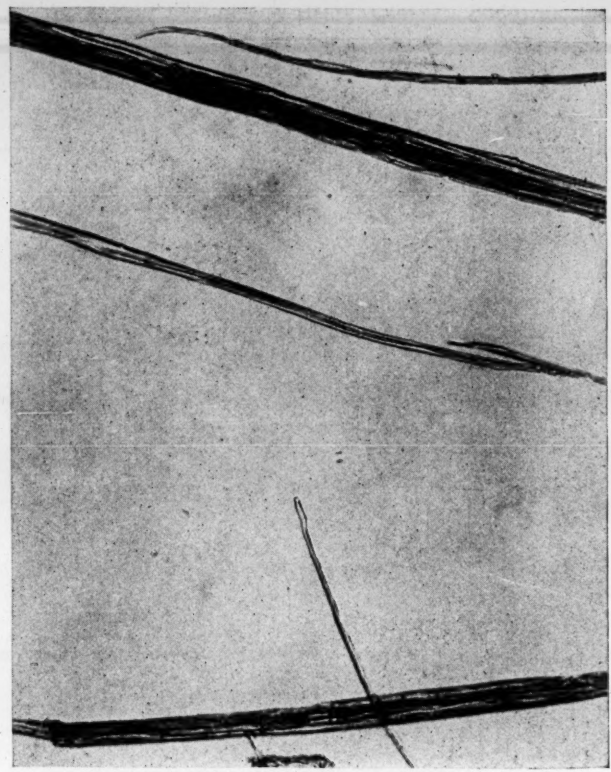

FIG. 6.—Longitudinal View of Jute (× 100).

Hemp (Common hemp, *Cannabis sativa*):

Hemp fibers are bast fibers from the inner bark of the hemp plant, *Cannabis sativa*.

Hemp fibers are composed of groups of long, blunt cells, not pointed at the ends as flax, though often of a forked shape. They all show large, well-defined lumens equal to or exceeding the thickness of the walls. There are usually pronounced longitudinal striations, and cross-lines are prominent, as are dislocations or folds, swellings and cross-fissures. The cell cross-sections are irregularly oval; the lumen flattened and irregular.

The commercial fibers are usually 3 to 8 ft. in length and in some kinds may be even longer. Dew-retted hemp is gray; water-retted hemp is light yellow; and steam or peeled and scraped hemp is semi-translucent.

There are several fibers miscalled hemp, but all are distinctly different from true hemp, and also different from each other. The following list indicates some of these fibers which are actually used in commerce:

Soft Fibers..............	Sunn Ambari Roselle
Hard Fibers.............	Abaca (Manila Hemp) Henequen Sisal Cantala Pitera Mescal Jaumave Tula Palma

Jute:

Jute fibers are bast fibers from the inner bark of two closely related plants, India jute, *Corchorus capsularis*, and Desi jute, *Corchorus olitorius*.

Jute fibers appear as bundles of fibers, shorter than hemp, with tapering and more pointed ends than hemp. The lumen is oval shaped, almost central, large and well defined, at times as wide or wider than the cell-walls and often remarkably constricted. The cross-sections of the cells are polygonal, five or six sided. There are longitudinal striations but no transverse markings nor jointed ridges. Externally the fibers are smooth and lustrous.

The prepared fibers may run from 4½ to 8 ft. in length and the crude fibers may be as long as 14 ft.

Ramie (Rhea):

Ramie fibers are bast fibers from the inner bark of the ramie or rhea plant, *Boehmeria nivea*.

Ramie fibers are long, somewhat tapering cells of uneven diameter with thick rounded ends. The diameter is irregular and the central canal or medullary space is sometimes quite distinct and at other times disappearing entirely. The canals are filled with granular matter and occupy from one-third to one-half the diameter. In cross-section the cells are more or less irregularly elliptical, but are often flattened and show very characteristic prominent cross-lines or fissures. The cell-walls are coarse, thickened irregularly at intervals, usually

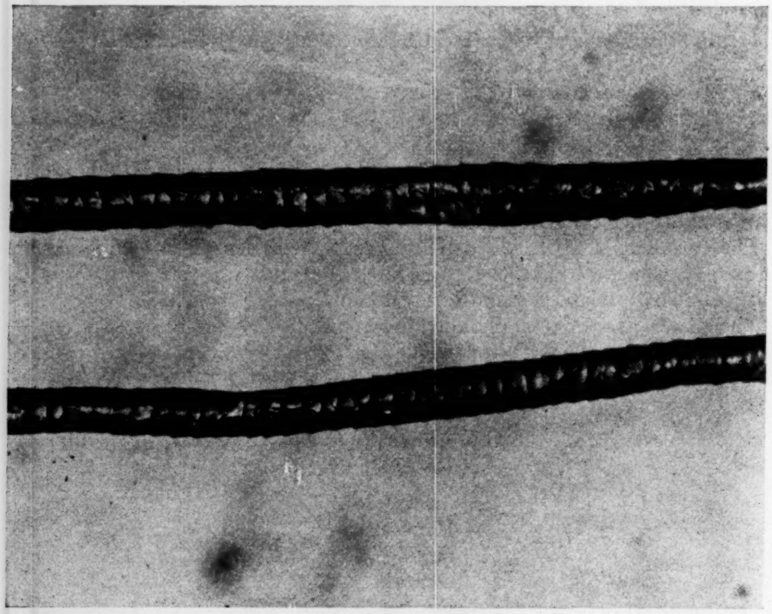

FIG. 8.—Longitudinal View of Wool (× 250)

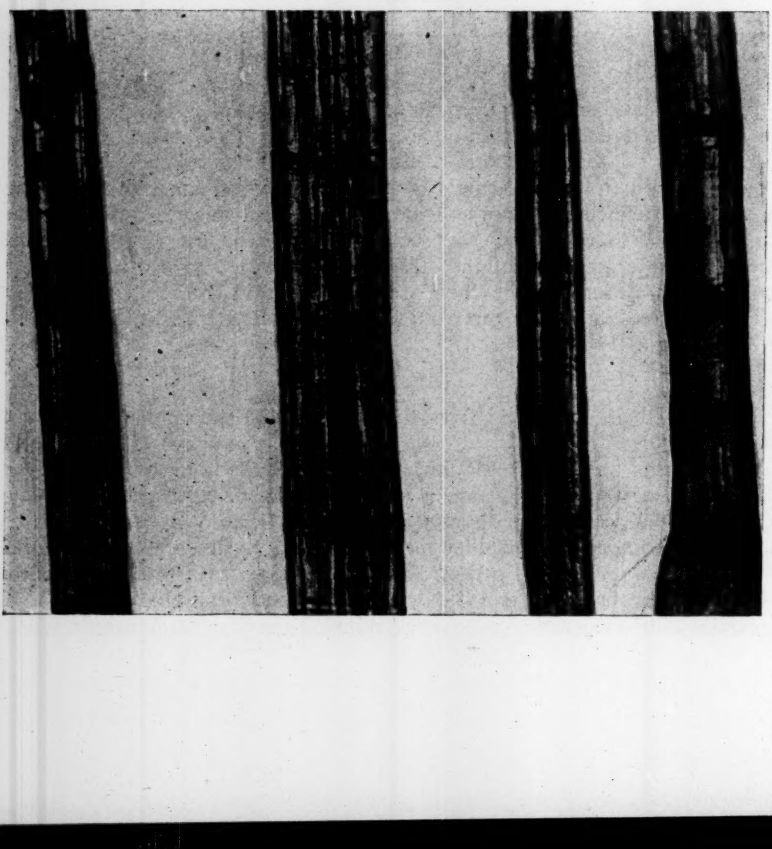

FIG. 7.—Longitudinal View of Ramie (× 250).

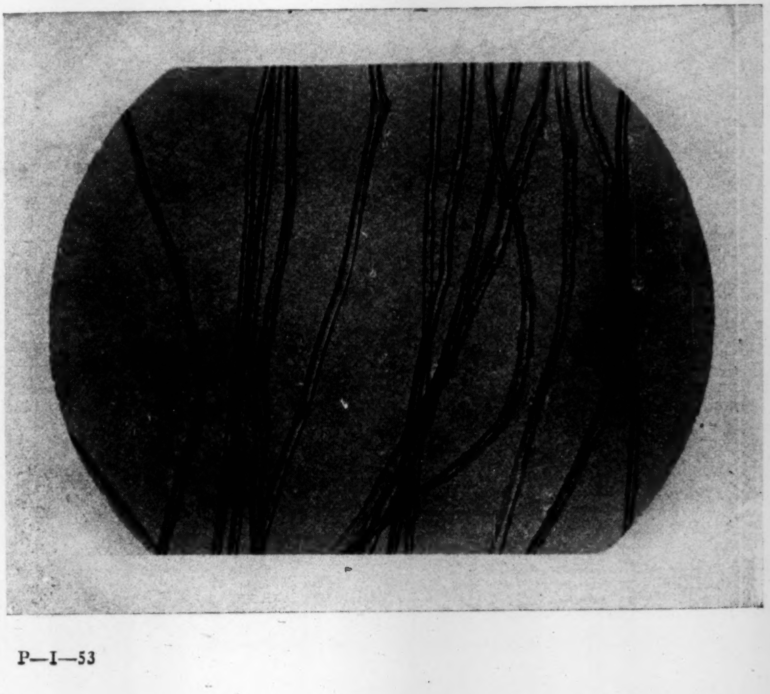

FIG. 9.—Longitudinal View of Silk (× 100).

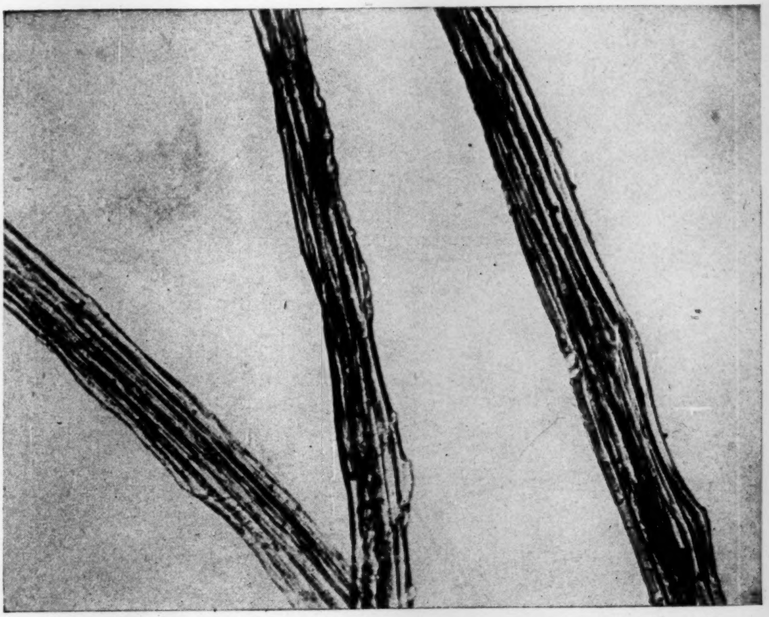

FIG. 10.—Longitudinal View of Raw Jap Silk (× 100).

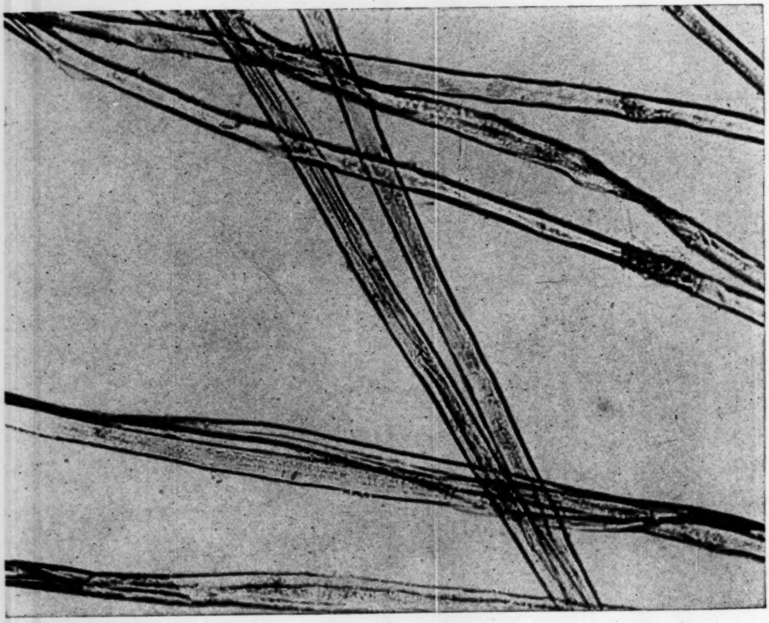

FIG. 11.—Longitudinal View of Tussah Silk (× 100).

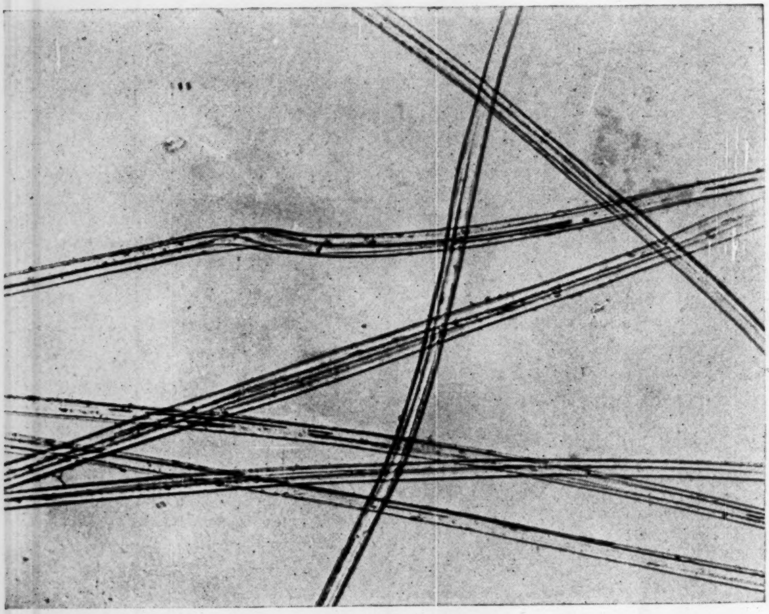

FIG. 12.—Longitudinal View of Cellulose Acetate Rayon (Celanese) (× 100).

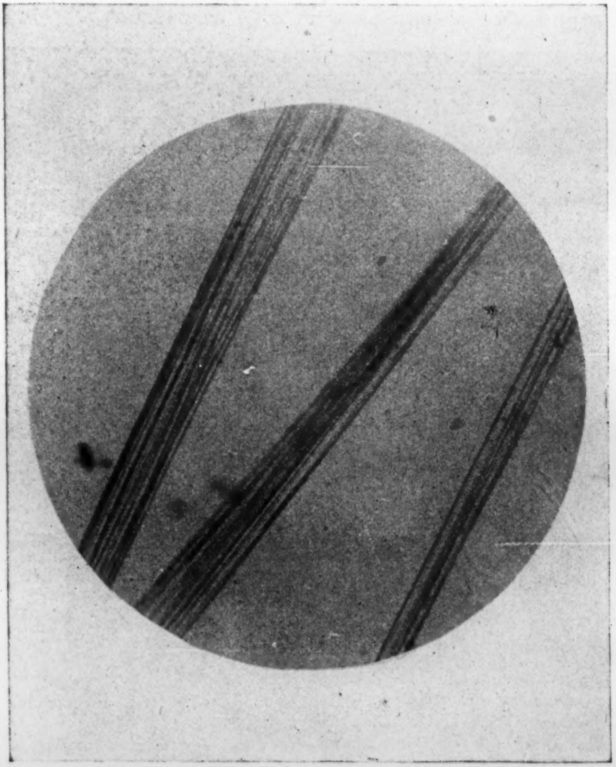

FIG. 13.—Longitudinal View of Xanthate of Cellulose Rayon (Viscose Co.) (× 100).

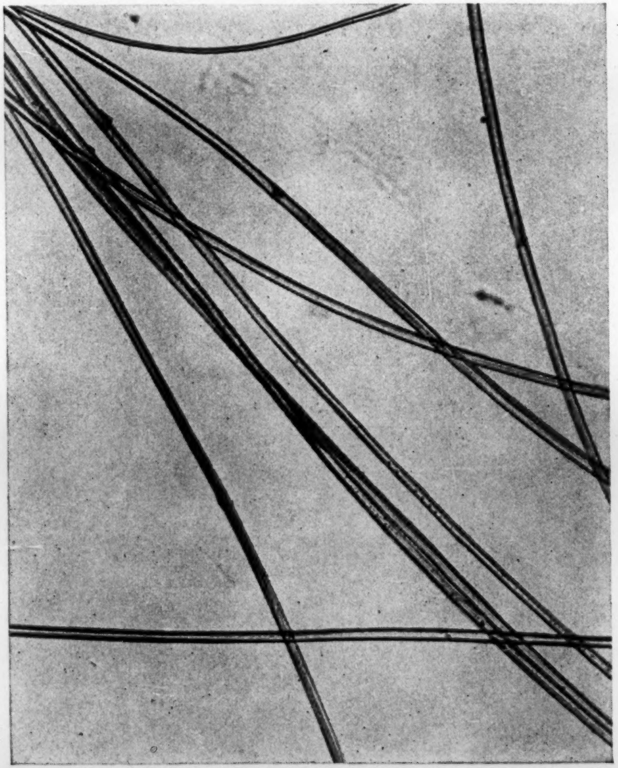

FIG. 14.—Longitudinal View of Cuprammonium Rayon (Bemberg) (× 100).

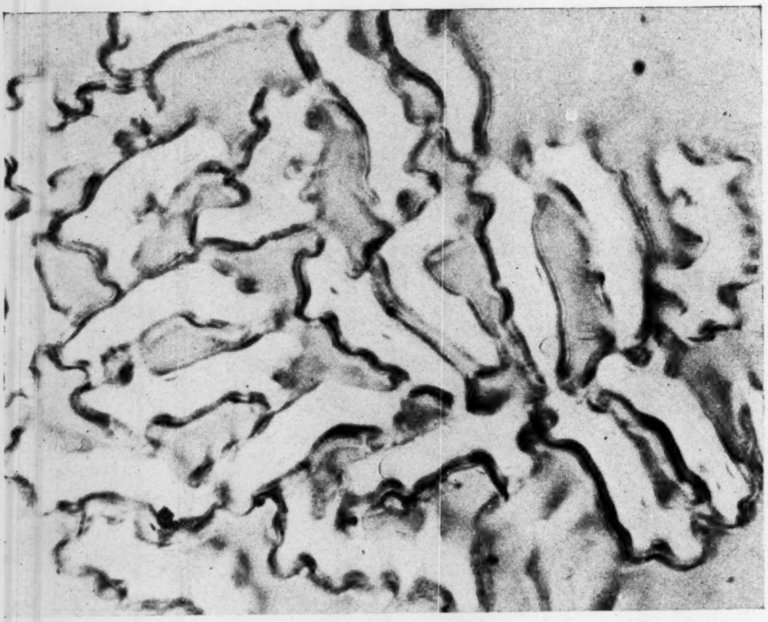

FIG. 16.—Cross-Section of Viscose Rayon, 150 Denier (DuPont Unbleached) (× 500).

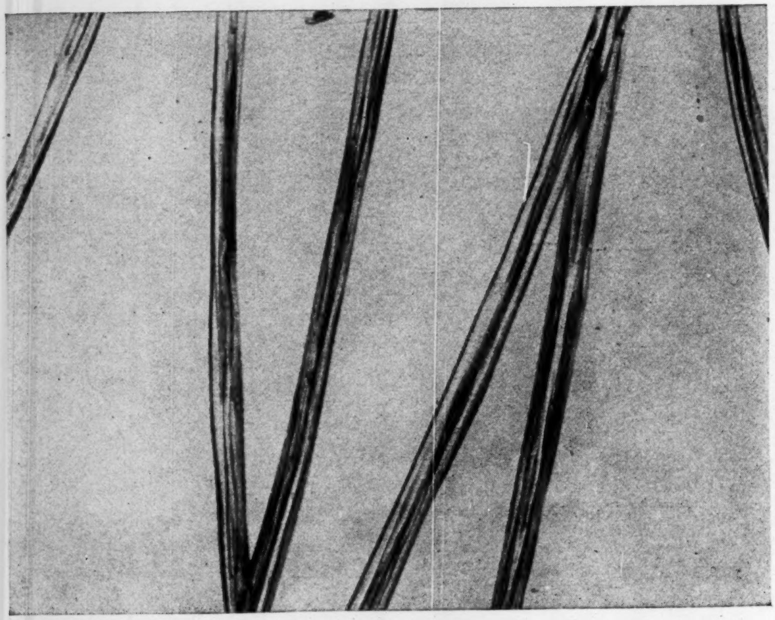

FIG. 15.—Longitudinal View of Nitro-cellulose Rayon (Tubize) (× 100).

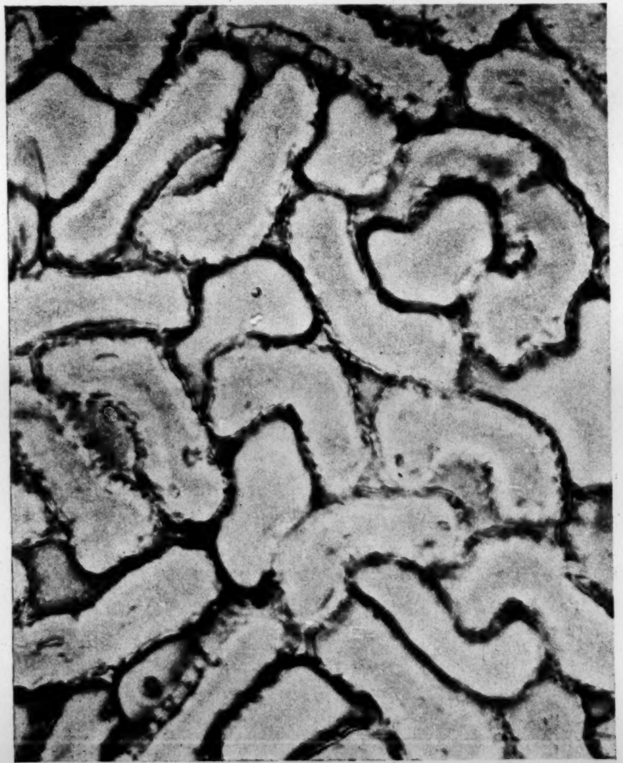

FIG. 17.—Cross-Section of Viscose Rayon, 300 Denier (Industrial Fiber Co.) (× 500).

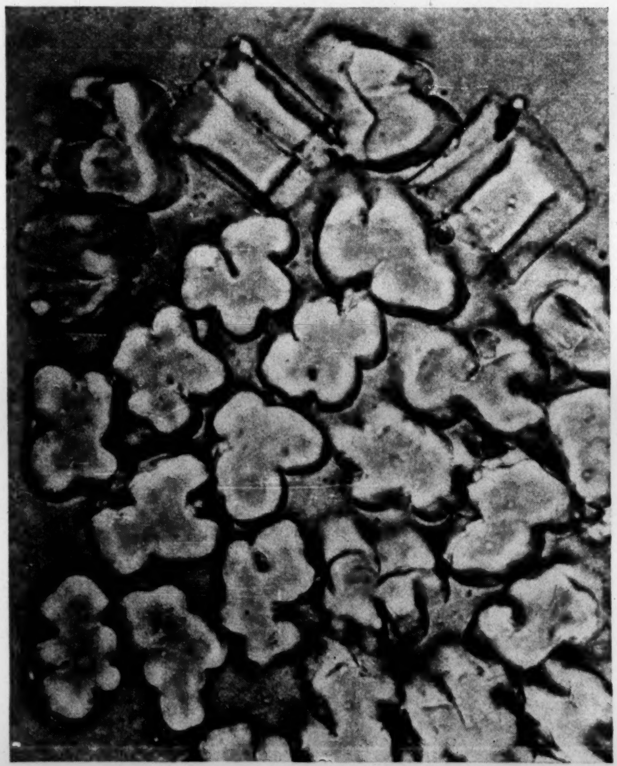

FIG. 18.—Cross-Section of Acetate Rayon, 150 Denier (Celanese) (× 500).

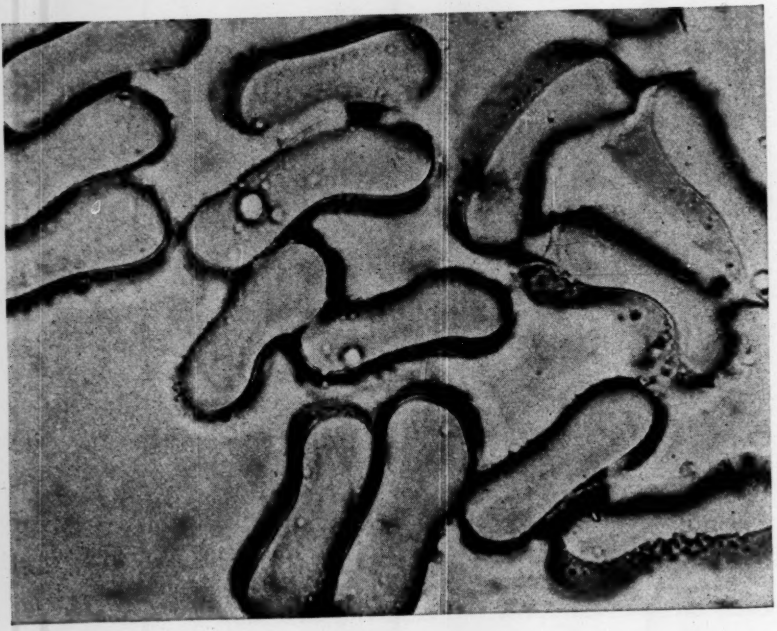

FIG. 19.—Cross-Section of Acetate Rayon, 150 Denier (Lustron Co.) (× 500).

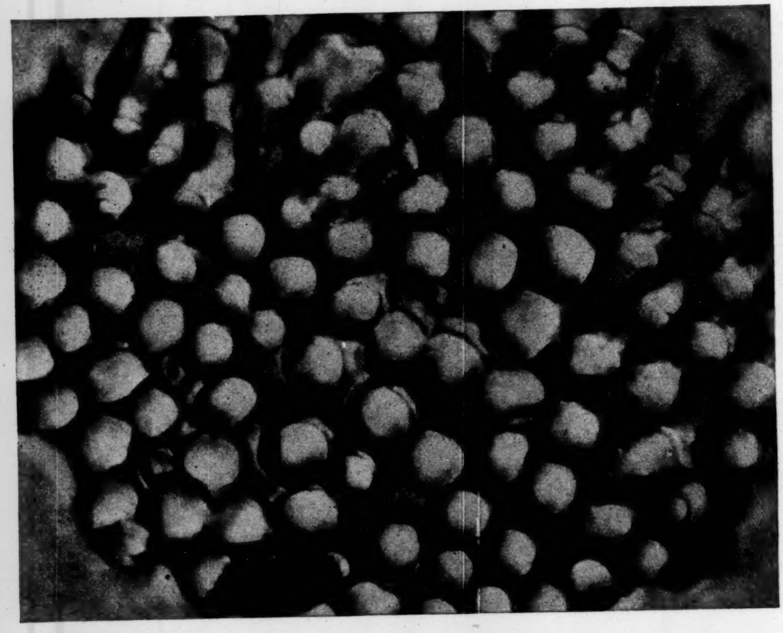

FIG. 20.—Cross-Section of Cuprammonium Rayon, 150 Denier (Bemberg) (× 500).

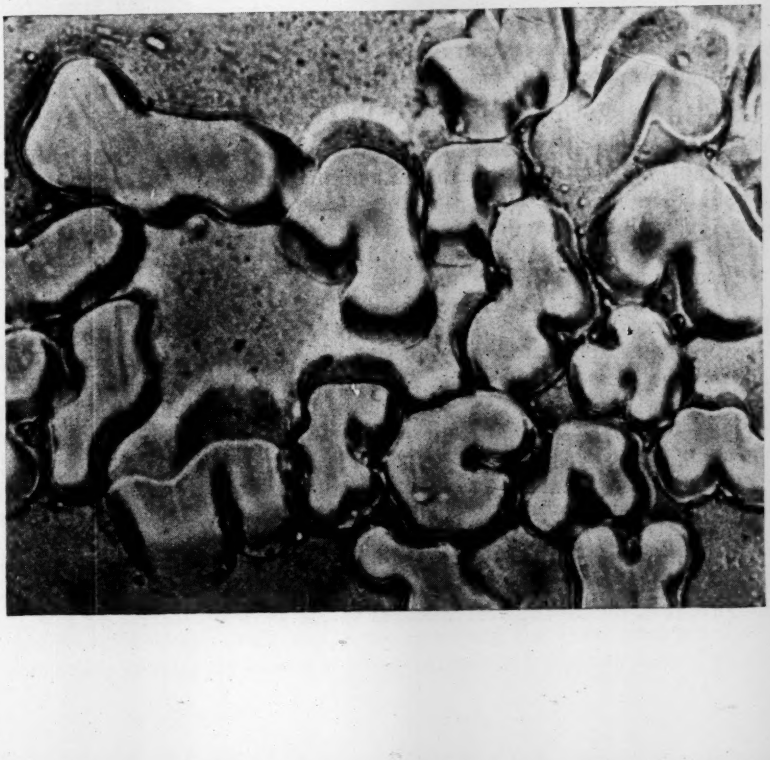

FIG. 21.—Cross-Section of Nitro-cellulose Rayon, 150 Denier (Tubize) (× 500).

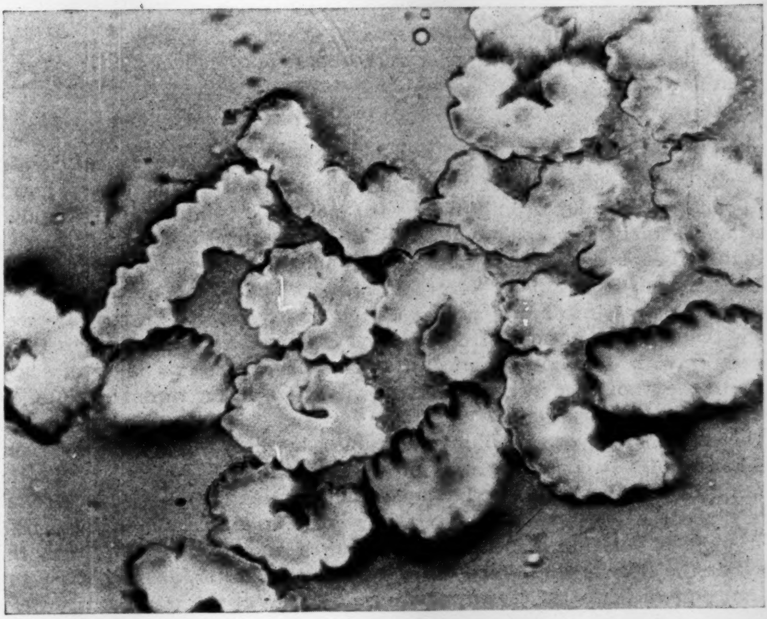

FIG. 22.—Cross-Section of Viscose Rayon, 150 Denier (Viscose Co.) (× 500).

exhibiting well-marked nodes, joints, and discolorations. There are many prominent deep longitudinal striations, crossed at irregular intervals.

Ramie is stronger than the other vegetable fibers but lacks their extensibility and flexibility.

Wool:

Wool hairs under the microscope show an outer scaly layer or cuticle and an inner fibrous layer or cortex which may or may not be pigmented, and a central canal or medulla, usually filled with more or less interrupted granular-appearing matter. The epidermal scales on the surface of the fiber can be readily discerned, even under low power magnification and these instantly distinguish the fiber from silk or vegetable fibers. The scales are more or less translucent in appearance and permit of the under cortical layer being seen through them. The nature, structure, and arrangement of the scales differ considerably with different varieties of wool. The epidermal layer of scales imparts to the wool fiber its characteristic quality of luster through the reflection of light from the surface.

The cortical layer or true fibrous portion of the fiber forms the major constituent of wool. It consists mainly of more or less elongated cells and often presents a distinctly striated appearance, the striations being visible through the translucent layers of scales. When fiber is fine in staple, the cortical cells exhibit more or less unevenness in their growth and arrangement, with the result that the fiber is contracted on one side or the other, causing the wavy appearance of such wools. Coarse wools seldom exhibit the wavy structure.

Silk:

Silk filaments after de-gumming have the appearance of a single, fine, structureless, cylindrical, transparent filament (rarely striated longitudinally), flattened in spots, and in cross-section round or irregularly oval.

The fibers are many hundreds of yards long.

Wild Silk (Tussah Silk):

Wild silk consists of flattened, ribbon-like filaments of much greater width than the mulberry silk, with many fine, longitudinal striations, and with frequent oblique depressions where the fibers have crossed one another in the cocoons. Such silks are obtained from a variety of species of silk worms other than those from which the cultivated silk (*Bombyx mori*) is obtained. The silks are usually brownish in color.

Rayons:

Viscose rayons appear to consist of ribbons scored with deep longitudinal striations. The cross-section of the filaments varies from irregular ovals to long and narrow figures which may be either straight or bent with rounded crescents. The ends of the figure are rounded, the sides are scored by notches corresponding to the longitudinal striations of the filament.

Cuprammonium (or cuprate) rayons appear as smooth rods quite uniform in diameter with sometimes fine longitudinal striations. The cross-section is oval or round.

Nitro-cellulose or collodion rayons appear as if composed of several very fine filaments which adhere to each other throughout their length. The cross-section appears as rounded figures attached to one another.

Acetate rayons appear as transparent structureless filaments with only fine striations. The cross-sections are ovals which are flattened or indented at several points or sides.

FIBER MICROSCOPY

Fiber microscopy requires a certain amount of delicate technique and skill and a knowledge of proper methods of preparing and mounting specimens for examination as well as of the proper selection of lenses. Care and skill resulting from considerable practice are required to bring out the markings and structure of the various fibers.

Microscope.—A reasonably good microscope together with a good system of first-class lenses is essential. The following table gives a suitable range of magnifications obtained from the objectives and eyepieces noted:

	Magnification	
Objective	Eye-Piece No. 5	Eye-Piece No. 10
4 mm	200	400
8 mm	100	200
16 mm	50	100

It is an advantage to have the microscope fitted with a revolving nose-piece suitable for the three objectives, in which case the specimen can be readily located and viewed under different magnifications. An adjustable stage is also a convenience in locating different portions of the mount as well as in focussing. With a sub-stage diaphragm and condenser, proper conditions of illumination can be easily obtained. These are usually supplied with a good microscope.

Mounting of Specimens.—For all practical purposes and where it is not necessary to preserve the slides with their mounts, the specimens may be mounted in water. A few fibers should be well separated or teased with suitable implements and cut in convenient lengths, if necessary, after which they are laid on the slide and moistened with a drop of water. The cover-glass is placed over them and gently pressed down so as to flatten the specimen. It is usually preferable to confine the specimen to few rather than many fibers in order to avoid tangles and distortion. If permanent mounts are desired the fibers may be mounted in Canada Balsam which dries and cements the cover-glass firmly in place. Such mounting, however, is not recommended until considerable experience in fiber microscopy has been gained.

QUANTITATIVE SEPARATION OF THE MOST COMMON TEXTILE FIBERS

Selective Dyeing Tests for Qualitative Identification

When little or nothing is known concerning the fibers present in a sample, it will be found desirable to first apply the following selective dyeing tests, which will indicate qualitatively the nature of the fibers present, after which more definite qualitative and finally quantitative tests may be applied.

Stripping of Sample.—If the fibers have already been dyed when received, the dye should be stripped off before making the test. This can usually be accomplished by boiling in a 3-per-cent solution of sodium hydrosulfite. After the color has been stripped, wash the material thoroughly with water to remove the stripping agent. All percentages given are based on the weight of the goods dyed.

Dyeing Tests.—Treat a piece of the sample in a solution of NaCl (3-per-cent) and Newport Direct Sky Blue FF (3-per-cent). Viscose takes a full shade of blue, while cellulose acetate is undyed.

Dye a piece of the sample at boiling for 30 minutes in a dye bath containing 1 per cent of indigo carmine and 2 per cent of acetic acid. Work the goods thoroughly while dyeing, then remove and wash well with water. Wool or silk take a full shade, while cotton and rayon are undyed.

Dye a piece of goods for 45 minutes just under boiling temperature in a bath containing 2 per cent of National Superchrome Red B (National Aniline and Chemical Co.) and 1.5 per cent of acetic acid. Then add 2 per cent of $K_2Cr_2O_7$ and boil for 30 minutes. Remove from the bath and wash thoroughly with water. Wool takes a full red shade while silk is undyed.

BURNING TEST FOR QUALITATIVE IDENTIFICATION OF VEGETABLE AND ANIMAL FIBERS

Burning Test.—The burning test may be employed as a quick means of distinguishing between vegetable and animal fibers. The vegetable fibers when ignited by a flame burn quickly and completely with the well-known odor of vegetable material; while animal fibers such as wool and silk burn more slowly with a distinct odor similar to burning glue and leave a globule of ashy matter. Silk yarn, which has been weighted with mineral salts, when ignited will not be entirely consumed and there will remain a fine mineral filament.

PROCEDURE FOR A COMPLETE QUANTITATIVE ANALYSIS

This procedure is for use in cases where an exhaustive knowledge of the several different fibers present in a sample is desired. In most cases, where not more than two different fibers are present in a sample and their identities are known qualitatively, the proper individual quantitative test may be advantageously applied directly, without first going through the general procedure.

PROCEDURE

Weigh out 2 to 5 g. of the sample in a glass-stoppered weighing bottle and dry at 100 to 110° C. to constant weight. The difference between the initial and final weights represents the moisture content. Boil the dry material thoroughly in dilute HCl (1-per-cent), care being taken not to disintegrate the fibers. If the fibers are much weakened or disintegrated, repeat with a new sample, using a weaker acid. Repeat the boiling with fresh portions of the acid until no residue is found upon evaporating a few drops of the liquid on a watch-glass. This treatment removes mineral loading matter soluble in HCl, finishing materials, more or less dyestuffs, as well as other material soluble in water.

Extract the residue first with alcohol and finally with carbon tetrachloride (CCl_4) until all soluble material is removed. Dry and weigh. Discard the extract. The residue is anhydrous fibers and any matter (mineral) not soluble in HCl. Divide immediately into two parts, and weigh each portion.

Reduce the first portion to ash. This will give the natural insoluble ash of the fibers, which is generally negligible, and any insoluble salts employed in mordanting or loading.

Heat to boiling about 60 cc. of basic $ZnCl_2$ solution, and immerse the second portion of the fibers. Remove the flame, stir the sample thoroughly for about one minute and again bring to boiling. Transfer immediately to a weighed Gooch crucible using the insoluble fibers as a mat for the crucible. Remove the insoluble fibers to a beaker containing cold, dilute HCl (5-per-cent). Thoroughly wash in the beaker by agitation and again filter. Repeat the process several times, using a weaker acid solution at each subsequent washing. Finally, remove the crucible and finish washing with several portions of hot water until free from chlorine as chloride. Dry at 100 to 105° C. and weigh.

The loss represents silk and in certain cases a portion of the sizing material. Also rayon or artificial silk is here removed.

Treat the residue with about 100 cc. of a solution of approximately 5-per-cent KOH and boil gently for 10 to 15 minutes. Pour into 500 cc. of cold water and let stand until the fibers have settled, and decant carefully the supernatant liquor, taking care to avoid loss of any fibers. Filter through a weighed Gooch crucible and wash thoroughly with boiling water. Moisten with a few cubic centimeters of dilute acetic acid and again wash with hot water, and finally with about 10 cc. of alcohol. Dry and weigh.

The loss in weight represents wool and a small portion of cotton. To correct for this add 3 per cent of the cotton to the cotton figure and subtract the same amount from the wool figure.

The residue is cotton or vegetable fibers (wood fiber, jute, linen, and similar material). Ignite. The loss represents the various vegetable fibers. The residue may consist of asbestos, mineral wool, or other mineral fibers, and should be examined qualitatively and microscopically.

QUANTITATIVE SEPARATIONS OF SAMPLES CONTAINING TWO OR MORE KINDS OF FIBERS

In all of the test procedures described below, all weighings are made on bone-dry material and losses are calculated on the original weight. For all practical purposes, the results so obtained are sufficiently reliable. However, where strictly commercially interpretable results are desired, the procedure must be followed after first correcting the bone-dry percentages to air-dry percentages, assuming the following standard regains at normal atmosphere:

	Standard Regains at Normal Atmosphere, per cent	Normal Regain Factor
Wool	14.0	$\frac{100}{114} = 0.877$
Rayon	11.5	$\frac{100}{111.5} = 0.897$
Silk	11.0	$\frac{100}{111} = 0.900$
Cotton and Cellulose Acetate	6.5	$\frac{100}{106.5} = 0.939$

Example.—A sample shows by analysis on a bone-dry basis:

Cotton	30.0 per cent
Wool	45.0 " "
Silk	25.0 " "
Total	100.0 per cent

Divide these percentages by their respective normal regain factors and obtain values in proportion to the normal atmosphere weights of these materials:

Cotton	$30.0 \div 0.939 = 32.0$
Wool	$45.0 \div 0.877 = 51.3$
Silk	$25.0 \div 0.900 = 27.8$
Total	111.1

By multiplying by $\frac{100}{111.1}$ there is obtained a total percentage of one hundred, and the component percentages are, therefore, the proportions of each fiber present in the material, on a basis of the proper normal regains, as follows:

Cotton	$32.0 \times \frac{100}{111.1} =$	28.8 per cent
Wool	$51.3 \times \frac{100}{111.1} =$	46.2 " "
Silk	$27.8 \times \frac{100}{111.1} =$	25.0 " "
Total	=	100.0 per cent

DETERMINATION OF MOISTURE AND SIZE LOSSES

In all of the following quantitative separations the standard procedure for determining the moisture and size losses is as follows and will not be repeated:

Weigh out 2 to 5 g. of the sample in a glass-stoppered bottle and dry at 100 to 110° C. to constant weight. The difference between the initial and final weights represents the moisture content, calculated as a percentage of the original weight. Remove the sizing materials from the residue by boiling with HCl solution (1-per-cent). Wash out the acid with water and dry at 105° C. to get the total weight of the fibers.

COTTON AND WOOL MIXTURES

PRELIMINARY

Weigh out a piece of the goods and dye it in a bath containing 3 per cent of indigo carmine and 2 per cent of acetic acid (both percentages based on the weight of the goods). Dye at boiling temperature for about 15 minutes, washing the goods thoroughly in the bath. The cotton will take a pale blue color and the wool will dye a much deeper blue. By examining the dyed cloth under a hand glass, a good approximation of the amount of wool present may be obtained.

PROCEDURE

Method A: Wool Content over 15 to 20 per cent:

Boil a known weight of the bone-dried and desized sample for 15 to 20 minutes with 5-per-cent KOH. Pour into 500 cc. of cold water, let settle, and decant the supernatant liquor. Filter through a weighed Gooch crucible and wash with hot water. Moisten with a few cubic centimeters of dilute acetic acid, again wash with hot water, and then with 10 cc. of alcohol. Dry and weigh. The difference between this weight and the weight of sample taken is the amount of wool plus 3 per cent of the cotton. To correct for this add 3 per cent of the cotton to the cotton figure and subtract the same amount from the wool figure.

Method B: Wool Content under 15 to 20 per cent:

Place a known weight of the sample in a considerable volume of a solution made by slowly stirring 80 cc. of concentrated H_2SO_4 (sp. gr. 1.84) into 25 cc. of water, previously cooled to room temperature. Work the sample in this mixture for about 15 minutes, removing it from time to time to another beaker and washing it with a stream of water into a strainer to remove the slimy product formed by the action of H_2SO_4 on the cotton. Finally, filter the residue into a weighed Gooch crucible, wash with water until entirely free from acid, as may be detected by litmus paper, dry in the oven at 100° C. and weigh the residue which in this case is wool.

COTTON, SILK, AND WOOL MIXTURES

The residue after removal of the sizing material is anhydrous fibers and any mineral matter not soluble in HCl. Divide immediately into two parts, weighing each.

Reduce the first portion to ash. This will give the natural insoluble ash of the fibers, which is generally negligible, and any insoluble salts employed in mordanting or loading.

Boil the second portion for 2 minutes in a solution of basic $ZnCl_2$ (sp. gr. 1.72), known as Elsner's reagent, which is prepared by dissolving 100 parts of $ZnCl_2$ and four parts of ZnO in 85 parts of hot water to complete solution. Wash the residue in dilute HCl and then in water until the acid has been completely removed as may be detected by litmus paper. The extract contains all the silk. The residue is cotton. Dry and weigh.

When only cotton and silk are present Method A as described under Cotton and Wool Mixtures should be used.

WOOL AND SILK MIXTURES

The residue after removal of the sizing material is anhydrous fibers and any mineral matter not soluble in HCl. Divide immediately into two parts, weighing each.

Reduce the first portion to ash. This will give the natural insoluble ash of the fibers, and any insoluble salts employed in mordanting or loading.

Dip the second portion in concentrated HCl for two minutes at 49° C. This will dissolve the silk and not materially affect the wool. Wash the residue well until all acid has been removed. Dry and weigh. The extract contains all the silk. The residue is wool.

SILK AND RAYON MIXTURES

Divide the residue after removal of sizing materials into two parts, weighing each.

Reduce the first portion to ash. This will give the natural insoluble ash of the fibers and any insoluble salts employed in mordanting or loading.

Treat the second portion at ordinary temperature for 20 minutes in an alkaline solution of copper sulfate known as Lowe's reagent, which is prepared by dissolving 10 g. of $CuSO_4 \cdot 5H_2O$ in 100 cc. of water, adding 5 cc. of glycerin and then adding a 20-per-cent caustic-soda solution until the precipitate formed redissolves. This will dissolve the natural silk, leaving the rayon as an insoluble residue. The extract contains all the silk. The residue is rayon.

ADDITIONAL TESTS FOR SILK AND RAYON MIXTURES

1. When treated with a cold semi-saturated solution of chromic acid silk is slowly soluble; all rayons except the acetate variety are soluble; while cotton and all other vegetable fibers are insoluble.

2. When treated with a 40-per-cent solution of potassium hydroxide, silk is acted upon at 65° C., dissolving at 85° C. and tussah silk swells at 75° C., dissolving at 120° C.; while rayons are insoluble on boiling.

3. In Schweitzer's reagent, silks, collodion and cellulose rayons are soluble, while gelatine rayon stains liquid-bright violet.

Schweitzer's Reagent:

Dissolve 5 g. of copper sulfate in 100 cc. of boiling water, add NaOH solution to complete precipitation; wash the precipitate thoroughly, then dissolve in the least quantity of NH_4OH. This should give a deep blue solution.

4. In Millon's Reagent a brick red color will develop with silk; while rayons remain white or uncolored.

Millon's Reagent:

Dissolve metallic mercury in its own weight of concentrated, c. p. HNO_3 (sp. gr. 1.42), then dilute this solution with an equal volume of water. Sometimes a new preparation of this reagent does not work (perhaps due to the nitric acid used), and so each lot should be tested by moistening scoured wool or real silk with it, gently warming and noting the production of a brick red color on the animal fiber. This reagent, if found reactive, should be kept in a small, tightly-stoppered bottle, when it will usually retain its staining power for a long time. It is used as a stain for animal fibers. The mixed or separated kinds of fibers are covered with a few drops of Millon's Reagent and gently warmed (not boiled).

TUSSAH SILK AND CULTIVATED MIXTURES

Divide the residue after removal of sizing materials into two parts, weighing each.

Reduce the first portion to ash. This will give the natural insoluble ash of the fibers, and any insoluble loading mordants, or tin salts.

Steep the second portion in cold concentrated HCl for 10 minutes, filter and wash the filter well with water until all acid has been removed, dry and reweigh. The extract contains all the silk. The residue is Tussah silk.

DIFFERENTIATION OF RAYONS

Samples tested by these methods shall be in the bleached or unbleached state and free from oil or other foreign substances.

TO DISTINGUISH CELLULOSE-ACETATE FROM ALL OTHER RAYONS

1. Twist fibers into a tight wad and then cautiously approach to a match flame, without being brought into contact with the flame.

Cellulose-acetate rayons melt or fuse, forming a black knob, or globule on the end, which precedes the small sputtering, relatively slow burning flame down the thread. If the flame be extinguished and the knob cooled, this will be found to be somewhat hard and resistant to crushing.

Nitro-cellulose, cuprammonium, and viscose rayons do not melt-back but burn quietly and readily like bleached cotton fibers and the odor from the fumes is the same as that coming from burned cotton.

2. Treat the sample with pure acetone:

Cellulose-acetate rayon is soluble up to 1 per cent while nitro-cellulose, cuprammonium, and viscose rayons are insoluble.

3. Treat the sample with glacial acetic acid (water white):

Cellulose-acetate rayon dissolves, and on adding water precipitates as a milky unstable emulsion or translucent gelatinous material.

Nitro-cellulose, cuprammonium, and viscose rayons are all insoluble.

TO DISTINGUISH NITRO-CELLULOSE RAYONS FROM VISCOSE AND CUPRAMMONIUM RAYONS

Treat the water-moistened yarn with a 1-per-cent solution of diphenylamine in concentrated H_2SO_4 (sp. gr. 1.84):

Nitro-cellulose rayon immediately assumes a blue color and dissolves in a few seconds, yielding a blue coloration.

Cuprammonium, and viscose rayons are not colored blue.

TO DISTINGUISH CUPRAMMONIUM RAYONS FROM VISCOSE RAYONS

1. Prepare a bath containing 1 per cent of the sample weight, of Pontamine Scarlet B or equivalent colors, using 0.5 g. per 200 cc. of water. Immerse samples into liquor simultaneously, heating to 65° C. for 10 minutes. The samples may then be washed thoroughly and compared wet or dry:

The cuprammonium rayons stain heavier, and the viscose rayons lighter.

2. Place 5 g. of the unknown sample of rayon (viscose or cuprammonium), together with 100 cc. of water and 3 cc. of concentrated H_2SO_4 (sp. gr. 1.84), in a flask, the mouth of which is covered with a piece of filter paper which has been saturated with a 10-per-cent solution of lead acetate; then place the flask over a moderately boiling steam bath for 4 hours. If at the end of this period the exposed part of the lead acetate paper becomes stained with a brown or black color, the rayon is viscose rayon; if no coloration is obtained the sample is cuprammonium rayon.

TENTATIVE REVISIONS
OF
A.S.T.M. STANDARDS

Tentative revisions of A.S.T.M. Standards are printed for one or more years with a view of eliciting criticisms, of which the committee concerned will take due cognizance before recommending final action.

Members of the Society and others are invited to direct written criticisms of any of these Tentative Revisions to the officer of the appropriate committee, whose name and address appear in the footnote in connection with each revision.

TENTATIVE REVISIONS OF A.S.T.M. STANDARDS

A. FERROUS METALS

STANDARD SPECIFICATIONS FOR OPEN-HEARTH CARBON-STEEL RAILS

(A.S.T.M. Designation: A 1 – 27)[1]

Section 23 (*b*).—Change from its present form: namely,

(*b*) No. 2 rails to the extent of 8 per cent of the whole order will be accepted.

to read as follows:

(*b*) No. 2 rails will be accepted to the extent of 8 per cent of the whole order of 39-ft. standard length rails and 5 per cent of the whole order of 33-ft. standard length rails.

STANDARD SPECIFICATIONS FOR STEEL TRACK SPIKES

(A.S.T.M. Designation: A 65 – 24)[1]

A revision in the form of separate tentative specifications entitled "Specifications for Soft Steel Track Spikes (A 65 – 26 T)"[2] is intended to replace the present standard specifications.

STANDARD SPECIFICATIONS FOR CARBON-STEEL AND ALLOY-STEEL FORGINGS

(A.S.T.M. Designation: A 18 – 28)[3]

Section 7 (*a*).—In the table change the manganese content of Class A steel from "0.30 – 0.55" to read "0.30 – 0.60."

STANDARD SPECIFICATIONS FOR BILLET-STEEL CONCRETE REINFORCEMENT BARS

(A.S.T.M. Designation: A 15 – 14)[1]

Section 2.—Omit Paragraph (*a*) reading as follows, designating Paragraph (*b*), as Section 2:

(*a*) The structural-steel grade shall be used unless otherwise specified.

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[1] 1927 Book of A.S.T.M. Standards, Part I, pp. 17, 59, 132, respectively. Criticisms of this revision are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 26, Part I, p. 631 (1926); also 1929 Book of A.S.T.M. Tentative Standards, p. 21.

[3] 1928 Supplement to Book of A.S.T.M. Standards, p. 9. Criticisms of this revision are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

Section 5.—Change to read as follows by the addition of the italicized words and figures:

> 5. The steel shall conform to the following requirements as to chemical composition:

Phosphorus	Bessemer	not over 0.10 per cent
	Open-hearth *Basic*	" " 0.05 "
	Open-hearth Acid	" " *0.08* "

Section 8.—Change the requirement for tensile strength of intermediate grade of both plain and deformed reinforcement bars as given in the table of Paragraph (*a*) from "70,000 to 85,000" to read "70,000 to 90,000," and add to the requirement for elongation in 8 in. of intermediate grade plain bars the provision "but not less than 16 per cent" and to the requirement for intermediate grade deformed bars "but not less than 14 per cent," both of these provisions to be subject to the modifications of Section 9.

STANDARD SPECIFICATIONS FOR IRON AND STEEL CHAIN

(A.S.T.M. Designation: A 56 – 24)[1]

A revision in the form of separate tentative specifications entitled "Specifications for Iron and Steel Chain (A 56 – 28 T)"[2] is intended to replace the present standard specifications.

STANDARD SPECIFICATIONS FOR WELDED AND SEAMLESS STEEL PIPE

(A.S.T.M. Designation: A 53 – 27)[3]

Section 3 (*b*).—Change the first sentence from its present form: namely,

> (*b*) Analyses may be made by the purchaser from each lot of 500 lengths or less of finished pipe.

to read as follows:

> (*b*) Analyses of two pipes in each lot of 500 lengths or less may be made by the purchaser.

Section 4 (*a*).—In the table of requirements add a footnote reference to the elongation value of 18 per cent for welded bessemer pipe, the footnote to read as follows:

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 404. Criticisms of this revision are solicited and should be directed to Mr. G. H. Woodroffe, Secretary of Committee A-2 on Wrought Iron, Reading Iron Co., 230 Park Ave., New York City.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 697 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 42.

[3] 1927 Book of A.S.T.M. Standards, Part I, p. 249. Criticisms of this revision are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

[a] Gage distances for measuring elongation on welded bessemer pipe of nominal sizes ¾-in. and smaller shall be as follows:

NOMINAL SIZE	GAGE LENGTH
¾ and ½ in.	6 in.
⅜ and ¼ in.	4 in.
⅛ in.	2 in.

STANDARD SPECIFICATIONS FOR LAP-WELDED AND SEAMLESS STEEL AND LAP-WELDED IRON BOILER TUBES

(A.S.T.M. DESIGNATION: A 83 - 27)[1]

Section 16 (*a*).—Change from its present form: namely,

16. (*a*) Finished tubes 4 in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over 4 in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter.

to read as follows:

16. (*a*) The outside diameter of finished tubes shall not vary more than $\frac{1}{64}$ in. over the size ordered. For finished tubes up to and including 4 in. in outside diameter, the outside diameter shall not vary more than $\frac{1}{32}$ in. under the size ordered, and for tubes over 4 in. in outside diameter, the outside diameter shall not vary more than $\frac{3}{64}$ in. under the size ordered.

Table II.—Change the table from its present form by the addition of weight requirements for four additional thicknesses, lighter than No. 14 gage and additional weight requirements for sizes ⅝ to ⅞ in. inclusive of tubes of thicknesses No. 14 gage and heavier, as indicated in italics in the accompanying Table I:

TABLE I.—STANDARD WEIGHTS OF SMALL SUPERHEATER TUBES.

THICKNESS		SEAMLESS ONLY WEIGHT, LB. PER FT. OF LENGTH OUTSIDE DIAMETER, IN.				
B.W.G.	IN.	⅝	$\frac{11}{16}$	¾	$\frac{3}{16}$	⅞
18	*0.049*	*0.301*	*0.334*	*0.367*	.....	.....
17	*0.058*	*0.351*	*0.390*	*0.429*	.....	.....
16	*0.065*	*0.389*	*0.432*	*0.476*	.....	.....
15	*0.072*	*0.425*	*0.473*	*0.521*	.....	.....
14	0.083	0.480	0.535	*0.591*	*0.647*	*0.702*
13	0.095	0.537	0.601	0.664	0.727	*0.791*
12	0.109	*0.600*	*0.673*	0.746	0.818	0.891
11	0.120	*0.647*	*0.717*	*0.807*	0.887	0.967
10	0.134	*0.702*	*0.792*	*0.881*	*0.971*	1.060
9	0.148	.....	.....	.....	.....	*1.149*

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 242. Criticisms of this revision are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

STANDARD SPECIFICATIONS FOR WELDED WROUGHT-IRON PIPE

(A.S.T.M. DESIGNATION: A 72 – 27)[1]

Section 1.—Add two sentences at the end of this section to read as follows:

Pipe ordered under these specifications is intended for coiling, bending, flanging and other special purposes. Butt-welded pipe is not intended for flanging and is not recommended for bending or coiling in sizes 1¼ in. or over.

Section 2.—Omit this section, reading as follows, and renumber the subsequent sections accordingly:

2. All pipes to be used on locomotives and cars shall be of coiling or bending quality.

Section 8.—Add a sentence at the end of this section to read as follows:

Double-extra-strong pipe over 1¼ in. in nominal size need not be subjected to the bend test.

Section 10.—Change Paragraph (*a*) from its present form: namely,

(*a*) Test specimens shall consist of sections cut from a pipe. They shall be smooth on the ends and free from burrs.

to read as follows:

(*a*) Tension test specimens may be of full section or strips cut longitudinally from the pipe. The sides of specimens shall be parallel and not flattened between gage marks.

Omit Paragraph (*b*), reading as follows, and reletter the present Paragraph (*c*) to read Paragraph (*b*):

(*b*) Tension test specimens shall be longitudinal.

Section 16.—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

16. For pipe 1½ in. or under in [inside diameter] ***nominal size,*** the outside diameter at any point shall not vary more than $\frac{1}{64}$ in. over nor more than $\frac{1}{32}$ in. under the standard [size] ***outside diameter.*** For pipe 2 in. or over in [inside diameter] ***nominal size,*** the outside diameter shall not vary more than 1 per cent over or under the standard [size] ***outside diameter.***

Section 17 (*c*).—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

(*c*) All threads shall be in accordance with the American Standard *Pipe Thread*[a] and cut so as to make a tight joint when the pipe is tested at the mill to the specified internal hydrostatic pressure. [The variation from the standard, when tested with the standard working gage, shall not exceed a maximum of one and one-half turns either way.]

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 377. Criticisms of this revision are solicited and should be directed to Mr. G. H. Woodroffe, Secretary of Committee A-2 on Wrought Iron, Reading Iron Co., 230 Park Ave., New York City.

Change the footnote from its present form: namely,

[a] A complete description of the American Standard Pipe Thread is contained in the Pipe Thread Standard prepared under the sponsorship of the American Gas Association and the American Society of Mechanical Engineers and approved as American Standard by the American Engineering Standards Committee.

to read as follows:

[a] A complete description of American Standard Pipe Threads applicable to pipe, valves and fittings, is contained in the Pipe Thread Bulletin published by the American Standards Association.

STANDARD SPECIFICATIONS FOR STAYBOLT, ENGINE-BOLT AND EXTRA-REFINED WROUGHT-IRON BARS

(A.S.T.M. DESIGNATION: A 84 – 27)[1]

Section 3 (*c*).—Change to read as follows by the omission of the words in brackets:

(*c*) *Box Pile.*—A box pile is a pile, the sides [top and bottom] of which are formed by [four] flat bars and the interior of which consists of a number of small bars the full length of the pile.

Section 7 (*a*).—Change to read as follows by the addition of the italicized words and the omission of those in brackets:

(a) Grade A.—For bars ⅞ in. [or under] in diameter, a reduction in the minimum elongation in 8 in. specified in Section 6 (a) shall be permitted, but in no case shall the elongation be less than 28 per cent. *For bars ¾ in. or under in diameter, the elongation shall not be less than 25 per cent.*

STANDARD SPECIFICATIONS FOR HOLLOW ROLLED STAYBOLT IRON

(A.S.T.M. DESIGNATION: A 86 – 27)[1]

Section 2 (*c*).—Change to read as follows by the omission of the words in brackets:

(*c*) *Box Pile.*—A box pile is a pile, the sides [top and bottom] of which are formed by [four] flat bars and the interior of which consists of a number of small bars the full length of the pile.

Section 5 (*a*).—Change the minimum requirement for reduction of area from 42 per cent to 48 per cent.

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[1] **1927 Book of A.S.T.M. Standards, Part I, pp. 381, 386.** Criticisms of this revision are solicited and should **be directed to Mr. G. H. Woodroffe,** Secretary of Committee A-2 on Wrought Iron, **Reading Iron Co., 230 Park Ave., New York City.**

STANDARD SPECIFICATIONS FOR CHILLED CAST-IRON WHEELS

(A.S.T.M. DESIGNATION: A 46 – 24)[1]

A revision in the form of separate tentative specifications entitled "Specifications for Chilled-Tread Cast-Iron Wheels (A 46 – 29 T)"[2] is intended to replace the present standard specifications.

STANDARD METHODS OF CHEMICAL ANALYSIS OF PLAIN CARBON STEEL

(A.S.T.M. DESIGNATION: A 33 – 24)[3]

A revision in the form of separate tentative methods of sampling entitled "Methods of Sampling Rolled and Forged Steel Products for Check Analysis (A 33 – 28 T)"[4] is intended to become a part of the present standard methods.

STANDARD METHODS OF TEST FOR MAGNETIC PROPERTIES OF IRON AND STEEL

(A.S.T.M. DESIGNATION: A 34 – 28)[5]

Section 5 (c).—Change to read as follows by the addition of the italicized figures and the omission of those in brackets:

(*c*) For permanent magnet steel, the residual induction and coercive force shall be determined from the maximum normal induction corresponding to a magnetizing force of [200] *300* gilberts per cm. unless the maximum permeability is less than 100, in which case the maximum magnetizing force shall be not less than 2½ times the value of the magnetizing force at which this maximum permeability occurs and shall be some multiple of [200] *300*.

B. NON-FERROUS METALS

STANDARD SPECIFICATIONS FOR BRONZE BEARING METAL IN INGOT FORM

(A.S.T.M. DESIGNATION: B 31 – 21)[6]

Section 3.—Replace the present table of requirements for chemical composition with the following:

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 432. Criticisms of this revision are solicited and should be directed to Mr. F. B. Coyle, Secretary of Committee A-3 on Cast Iron, International Nickel Co., 67 Wall St., New York City.

[2] See p. 574.

[3] 1927 Book of A.S.T.M. Standards, Part I, p. 276. Criticisms of this revision are solicited and should be directed to Mr. V. H. Lawrence, Secretary of Committee A-1 on Steel, Alan Wood Steel Co., Conshohocken, Pa.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 756 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 112.

[5] 1928 Supplement to Book of A.S.T.M. Standards, p. 29. Criticisms of this revision are solicited and should be directed to Mr. R. L. Sanford, Secretary of Committee A-6 on Magnetic Properties, U. S. Bureau of Standards, Washington, D. C.

[6] 1927 Book of A.S.T.M. Standards, Part I, p. 586. Criticisms of this revision are solicited and should be directed to Mr. D. K. Crampton, Secretary of Committee B-5 on Copper and Copper Alloys, Cast and Wrought, Chase Metal Works, Waterbury, Conn.

Alloy, Grade No.	Copper, per cent	Tin, per cent	Lead, per cent	Phosphorus, per cent	Impurities, maximum, per cent						Constituents Other than Copper, Tin, Lead and Phosphorus, per cent
					Zinc	Iron	Nickel	Antimony	Aluminum	Sulfur	
1........	85	10	5	0.70[a]	0.25	0.25	0.25	0.75	none	0.05	0.50 - 1.00
2........	80	10	10	0.70[a]	0.50	0.25	0.25	0.75	none	0.05	0.75 - 1.25
3........	80	10	10	0.05[b]	2.00	0.25	0.25	0.75	none	0.05	2.50 - 3.00
4........	77	8	15	0.25[b]	0.50	0.25	0.25	0.75	none	0.05	0.75 - 1.25
5........	73	7	20	0.05[b]	0.50	0.25	0.25	0.75	none	0.05	1.00 - 1.25
6........	70	5	25	none	0.50	0.25	0.25	0.75	none	0.05	1.00 - 1.25

[a] Minimum. [b] Maximum.

Section 4.—In the table of permissible variations for the percentage of elements specified over 10 per cent, change the permissible variations over and under the specified value from "1.50 per cent" to "2.00 per cent."

STANDARD METHODS OF CHEMICAL ANALYSIS OF MANGANESE BRONZE

(A.S.T.M. DESIGNATION: B 27 - 19)[1]

Under the Determination of Manganese by the Persulfate Method, change the description under Method from its present form: namely,

> In a 250-cc. Erlenmeyer flask dissolve 1 g. of bronze in 24 cc. of the "solution for dissolving." Allow to stand on a steam bath or hot plate until entirely dissolved, and until the oxides of nitrogen are expelled. Add 15 cc. of $AgNO_3$ solution and 20 cc. of ammonium persulfate and leave on the steam bath until the solution has developed a full permanganate color and no bubbles can be seen to come off when the flask is given a whirling motion. Cool to below 25° C. in running water, and add 50 cc. of cold water. Titrate with standard sodium-arsenite solution to the disappearance of the pink color.

to read as follows:

> Adjust the size of sample to the expected percentage so that the portion taken does not contain more than 0.002 g. manganese. Place it in a 250-cc. Erlenmeyer flask with 24 cc. of the "solution for dissolving" and heat until solution is complete. Boil until oxides of nitrogen are expelled. Dilute to 100 cc. with boiling-hot water, add 20 cc. of $AgNO_3$ solution and 30 cc. of the persulfate solution, then remove to a moderately warm place to stand for a few minutes for complete development of the permanganic acid. Cool to below 25° C., and titrate with the standard arsenite solution to the disappearance of the pink color.

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[1] 1927 Book of A.S.T.M. Standards, Part I, p. 700. Criticisms of this revision are solicited and should be directed to Mr. E. E. Thum, Secretary of Committee B-2 on Non-Ferrous Metals and Alloys, *The Iron Age*, 239 W. Thirty-ninth St., New York City.

C. CEMENT, LIME, GYPSUM AND CLAY PRODUCTS

STANDARD SPECIFICATIONS AND TESTS FOR PORTLAND CEMENT

(A.S.T.M. DESIGNATION: C 9 – 26)[1]

A revision in the form of a separate tentative standard entitled "Specifications and Tests for Compressive Strength of Portland-Cement Mortars (C 9 – 16 T)"[2] is intended to become a part of the present standard specifications.

STANDARD SPECIFICATIONS FOR HYDRATED LIME FOR STRUCTURAL PURPOSES

(A.S.T.M. DESIGNATION: C 6 – 24)[3]

Section 12.—Change the second and fifth paragraphs from their present form: namely,

> The lime shall be made into a stiff putty with water and permitted to soak over night. It shall be molded in a rubber ring such as is used with a Vicat needle, resting the specimen on a glass plate.
>
> If the penetration is less than standard, the sample may be removed from the mold, mixed with more water, and retested. If the penetration is more than standard, the sample shall be discarded and a new one prepared.

to read respectively as follows:

> The lime shall be made into a stiff putty with water, stirred vigorously with a trowel or spatula for three minutes and permitted to soak over night. It shall be stirred vigorously with a trowel or spatula for three minutes, molded in a rubber ring such as is used with a Vicat needle, resting the specimen on a glass plate.
>
> If the penetration is less than standard, the sample may be removed from the mold, mixed with more water, stirred vigorously with a trowel or spatula for three minutes, and retested. If the penetration is more than standard, the sample shall be discarded and a new one prepared.

Section 13.—Change the first paragraph to read as follows by the addition of the italicized words:

> 13. Plasticity shall be determined by means of the apparatus shown in Fig. 1 as follows: Three hundred grams of the sample shall be mixed with enough water to form a thick putty ***and stirred vigorously for 3 minutes with a trowel or spatula.*** After aging in a vessel covered with a damp cloth for not less than 16 nor more than 24 hours, this putty shall be ***stirred vigorously for 3 minutes with a trowel or spatula and*** adjusted to standard consistency, as defined in Section 12, with a permissible variation of ± 5 mm.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 23. Criticisms of this revision are solicited and should be directed to Mr. F. H. Jackson, Secretary of Committee C-1 on Cement, U. S. Bureau of Public Roads, Washington, D. C.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. XX, Part I, p. 599 (1920); also 1929 Book of A.S.T.M. Tentative Standards, p. 196.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 47. Criticisms of this revision are solicited and should be directed to Mr. H. C. Berry, Chairman of Committee C-7 on Lime, University of Pennsylvania, Philadelphia, Pa.

Omit the last paragraph of this section reading as follows:

After each test, the porcelain base plate shall be washed with hot water, treated with dilute hydrochloric acid to remove any lime from the surface pores, washed again with water, to remove the acid, dried by heating about 100° C., and cooled to room temperature before it is used again.

Figure 1.—Revise the constants given under the illustration of the Emley Plasticimeter by changing the first line from its present form: namely,

Absorption of porcelain base plate.—20 to 25 per cent.

to read as follows:

Absorption of porcelain base plate.—Minimum 40 g. in 24 hours. For rate of absorption of base plates, see Section 15.

Add two new sections, numbered 14 and 15, to read as follows, renumbering the present Section 14 to read Section 16:

14. *Cleaning and Care of Base Plates.*—In making plasticity determinations much of the success attainable depends upon the condition of the base plates. Continued use of the plates without proper cleaning results in clogging of the pores, with reduction in the rate of absorption. After a plate has been used the excess lime shall be wiped off and the plate immersed in clear water for not less than two hours, after which it shall be transferred without drying to a dilute solution of hydrochloric acid (1:9) where it shall be kept immersed for another two hours. It should then be transferred to a receptacle containing running water for at least one hour. The plate is then free of acid and after the removal of excess water should be placed in an oven at a temperature of between 100 and 110° C. overnight for drying. Before using, the plate shall be cooled to room temperature.

15. *Absorption of Plasticimeter Base Plates.* (*a*) *Total Absorption.*—Plasticimeter base plates when immersed in water at room temperature for a period of 24 hours shall absorb not less than 40 g. of water. Before making the determination the plates shall be dried overnight in an oven at a temperature of between 100 and 110° C. and permitted to cool to room temperature. After immersion and before weighing, the excess water shall be wiped off with a damp cloth.

(*b*) *Rate of Absorption.*[a]—When tested over an area 2¾ in. in diameter the water absorbed shall be in accordance with the following:

	WATER ABSORBED, CC.
First Minute	8 to 14
Second Minute	5 to 7½
Third Minute	4 to 6½
Fourth Minute	4 to 6
Fifth Minute	3½ to 5½

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[a] A convenient apparatus for determining the rate of absorption consists of a burette sealed onto an inverted glass funnel from which the stem has been removed. The diameter of the larger end of the funnel shall be ground so as to be 2¾ in. in internal diameter. The funnel may be attached to the plate on which the measurement is being made by melted paraffin. The paraffin should not be too hot. A little experience will indicate when it is of the proper consistency.

STANDARD SPECIFICATIONS FOR CEMENT-CONCRETE SEWER PIPE

(A.S.T.M. DESIGNATION: C 14 - 24)[1]

Section 1.—Add the following footnote:

Caution.—The consumer or purchaser is cautioned against using cement-concrete pipe where the sewage shows an acid reaction.

STANDARD SPECIFICATIONS AND TESTS FOR HOLLOW BURNED-CLAY LOAD-BEARING WALL TILE

(A.S.T.M. DESIGNATION: C 34 - 27)[2]

Section 2 (a).—Change the wording and the absorption requirements of this section from the present form: namely,

2. (*a*) According to the results of physical tests, tile shall be classified as Hard, Medium and Soft on the basis of the following strength and absorption requirements, both of which must be met for a given class:

Class	Absorption, per cent		Compressive Strength Based on Gross Area, lb. per sq. in.			
	Mean of 5 Tests	Individual Maximum	End Construction		Side Construction	
			Mean of 5 Tests	Individual Minimum	Mean of 5 Tests	Individual Minimum
Hard	12 or less	15	2000 or more	1400	1000 or more	700
Medium	16 or less	19	1400 or more	1000	700 or more	500
Soft	25 or less	28	1000 or more	700	500 or more	350

to read as follows:

2. (*a*) According to the results of the physical tests, tile shall be classified as Hard, Medium and Soft on the basis of the following strength and absorption requirements, the class of any lot being determined by the requirement which gives it the lowest rating:

Class	Absorption, per cent			Compressive Strength Based on Gross Area, lb. per sq. in.			
	Mean of 5 Tests	Individual Maximum	Individual Minimum	End Construction		Side Construction	
				Mean of 5 Tests	Individual Minimum	Mean of 5 Tests	Individual Maximum
Hard	6 to 12	15	5	2000 or more	1400	1000 or more	700
Medium	12 to 16	19	5	1400 or more	1000	700 or more	500
Soft	16 to 25	28	5	1000 or more	700	500 or more	350

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 179. Criticisms of this revision are solicited and should be directed to Mr. E. S. Rankin, Secretary of Committee C-4 on Clay and Cement-Concrete Pipe, Bureau of Sewers, City Hall, Newark, N. J.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 213. Criticisms of this revision are solicited and should be directed to Mr. H. D. Foster, Secretary of Committee C-10 on Hollow Masonry Building Units, Ohio State University, Columbus, Ohio.

Section 3 (*a*).—It is recommended that the 2-cell 8 by 5 by 12-in. unit weighing 16 lb. and the 6-cell 12 by 12 by 12-in. unit weighing 48 lb. be eliminated from the table of weights.

STANDARD SPECIFICATIONS AND TESTS FOR HOLLOW BURNED-CLAY FLOOR TILE

(A.S.T.M. DESIGNATION: C 57 – 27)[1]

Section 2 (*a*).—Change the wording and the absorption requirements of this section from their present form: namely,

2. (*a*) According to the results of physical tests, tile shall be classified as Hard, Medium and Soft on the basis of the following strength and absorption requirements, both of which must be met for a given class:

Class	Absorption, per cent		Compressive Strength Based on Net Area, lb. per sq. in.			
			End Construction		Side Construction	
	Mean of 5 Tests	Individual Maximum	Mean of 5 Tests	Individual Minimum	Mean of 5 Tests	Individual Minimum
Hard	12 or less	15	4600 or more	3000	2400 or more	1700
Medium	16 or less	19	3200 or more	2250	1600 or more	1100
Soft	25 or less	28	2000 or more	1400	1200 or more	850

to read as follows:

2. (*a*) According to the results of the physical tests, tile shall be classified as Hard, Medium and Soft on the basis of the following strength and absorption requirements, the class of any lot being determined by the requirement which gives it the lowest rating:

Class	Absorption, per cent			Compressive Strength Based on Net Area, lb. per sq. in.			
				End Construction		Side Construction	
	Mean of 5 Tests	Individual Maximum	Individual Minimum	Mean of 5 Tests	Individual Minimum	Mean of 5 Tests	Individual Minimum
Hard	6 to 12	15	5	4600 or more	3000	2400 or more	1700
Medium	12 to 16	19	5	3200 or more	2250	1600 or more	1100
Soft	16 to 25	25	5	2000 or more	1400	1200 or more	850

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 219. Criticisms of this revision are solicited and should be directed to Mr. H. D. Foster, Secretary of Committee C-10 on Hollow Masonry Building Units, Ohio State University, Columbus, Ohio.

STANDARD METHOD OF TEST FOR SOFTENING POINT OF FIRE-CLAY BRICK

(A.S.T.M. DESIGNATION: C 24 – 28)[1]

Section 5 (a).—In the table of heating rates change the time intervals for cones 31 to 35 to read as follows by the addition of the italicized figures and the omission of those in brackets:

Time interval to cone 31	[8] *12* minutes
" " " " 32	[4] *8* "
" " " " 33	[8] *18* "
" " " " 34	[18] *6* "
" " " " 35	[6] *10* "

STANDARD METHODS OF MAKING AND STORING SPECIMENS OF CONCRETE IN THE FIELD

(A.S.T.M. DESIGNATION: C 31 – 27)[2]

Section 4 (a).—Add the following sentence between the first and second sentences:

> When impracticable to obtain a representative sample from the concrete after it has been placed in the work, samples shall be taken as the concrete is being delivered at the point of deposit, care being taken to obtain a sample representative of the entire batch.

Section 6.—Designate this section as Paragraph 6 (*a*) and replace the first sentence reading as follows:

> Two to four hours after molding, the test specimens shall be capped with a thin layer of stiff neat-cement paste in order that the cylinder may present a smooth end for testing.

with the following two sentences:

> Specimens shall not be removed from the place of molding within 24 hours and during this time shall be protected from the elements by the same method of protection as is used for the portion of the structure which the specimens represent. If steel forms are used, the specimens may be capped with a thin layer of stiff neat-cement paste from 2 to 4 hours after molding in order that the cylinder may present a smooth end for testing.

Add a new Paragraph (*b*), reading as follows:

> (*b*) Where specimens are not capped in the field, they shall be capped before testing in such a manner that the ends are perfectly plane and at right angles to the axis of the cylinder. The material used for capping and the thickness of the cap shall be such that it will not flow under the load.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 89. Criticisms of this revision are solicited and should be directed to Mr. L. J. Trostel, Secretary of Committee C-8 on Refractories, General Refractories Co. Laboratories, Box 935, Baltimore, Md.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 108. Criticisms of this revision are solicited and should be directed to Mr. Stanton Walker, Secretary of Committee C-9 on Concrete and Concrete Aggregates, National Sand and Gravel Assn., 545 Munsey Building, Washington, D. C.

Sections 7 and 8.—Replace these sections, reading as follows:

7. At the end of 48 hours the test specimens shall be removed from the molds and buried in damp sand except in case the molds shown in Fig. 3 are used, when they may be buried in damp sand without removal of the mold, thus permitting shipping in the molds.

8. (*a*) The test specimens shall remain buried in damp sand until 10 days prior to the date of test. They shall then be well packed in damp sand or wet shavings and shipped to the testing laboratory, where they shall be stored either in a moist room or in damp sand until the date of test.

(*b*) Should a 7-day test be required, the test specimens shall remain at the work as long as possible to harden and then shall be shipped so as to arrive at the laboratory in time for test on the required date.

(*c*) Test specimens shall be protected from drying after removal from damp storage and before testing.

with a new Section 7 reading as follows:

7. (*a*) At the end of 24 hours, test specimens shall be removed from the place of casting and, if desired, forms may be removed. Those specimens intended for laboratory control tests shall be placed under moist curing conditions at approximately 70° F. and maintained therein until tested.

(*b*) The specimens intended for field control tests shall be kept on the structure as near the point of sampling as possible and yet receive the same protection from the elements on all surfaces and in all respects as is given to the portions of the structure which they represent. Field control specimens shall be protected from injury while on the work. They shall be sent to the laboratory not more than 7 days prior to the time of test and while in the laboratory shall be kept in ordinary air at room temperatures until tested.

STANDARD DEFINITIONS OF TERMS RELATING TO THE GYPSUM INDUSTRY

(A.S.T.M. DESIGNATION: C 11 - 28)[1]

Several definitions of terms published under the title "Tentative Definitions of Terms Relating to the Gypsum Industry (C 11-29 T)"[2] are intended to be added to the present standard definitions.

STANDARD DEFINITION OF THE TERM SAND

(A.S.T.M. DESIGNATION: C 58 - 28)[3]

The Tentative Definition of the Term Aggregate (C 58 - 28 T)[4] is intended to be included, when adopted, with the present Standard Definition of the Term Sand.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 92. Criticisms of this revision are solicited and should be directed to Mr. H. J. Schweim, Secretary of Committee C-11 on Gypsum, United States Gypsum Co., 300 W. Adams St., Chicago, Ill.

[2] See p. 627.

[3] 1928 Supplement to Book of A.S.T.M. Standards, p. 95. Criticisms of this revision are solicited and should be directed to Mr. F. E. Giesecke, Chairman of the Sub-Committee on Definition of Sand and Aggregate of Committee E-8 on Nomenclature and Definitions, Agricultural and Mechanical College of Texas, College Station, Tex.

[4] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 835 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 220.

STANDARD DEFINITIONS OF TERMS RELATING TO REFRACTORIES

(A.S.T.M. DESIGNATION: C 71 – 28)[1]

Several definitions of terms published under the title "Tentative Definitions of Terms Relating to Refractories (C 71 – 28 T)"[2] are intended to be added to the present standard definitions.

D. MISCELLANEOUS MATERIALS

STANDARD SPECIFICATIONS FOR DRY BLEACHED SHELLAC

(A.S.T.M. DESIGNATION: D 207 – 26)[3]

A revision in the form of separate tentative specifications entitled "Specifications for Dry Bleached Shellac (D 207 – 29 T)"[4] is intended to replace when adopted the present standard specifications.

STANDARD SPECIFICATIONS FOR ORANGE SHELLAC

(A.S.T.M. DESIGNATION: D 237 – 27)[3]

A revision in the form of separate tentative specifications entitled "Specifications for Orange Shellac (D 237 – 29 T)"[5] is intended to replace when adopted the present standard specifications.

STANDARD SPECIFICATIONS FOR BROKEN SLAG FOR WATERBOUND BASE AND WEARING COURSE

(A.S.T.M. DESIGNATION: D 65 – 23)[6]

Section 4.—Omit this section, reading as follows, renumbering the subsequent sections accordingly:

4. The percentage of wear shall be not more than 12.0 per cent.

Section 6.—Change the last line of this section to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

[Retained on] *Passing* 2½-in. screen . . . not [less] *more* than [85] *15* per cent.

Section 7 (b).—Omit this paragraph which refers to the method for determining the percentage of wear.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 98. Criticisms of this revision are solicited and should be directed to Mr. L. J. Trostel, Secretary of Committee C-8 on Refractories, General Refractories Co. Laboratories, Box 935, Baltimore, Md.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 858 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 248.

[3] 1927 Book of A.S.T.M. Standards, Part II, pp. 239, 241. Criticisms of this revision are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

[4] See p. 637.

[5] See p. 638.

[6] 1927 Book of A.S.T.M. Standards, Part II, p. 451. Criticisms of this revision are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-4 on Road and Paving Materials, 441 Lexington Ave., New York City.

STANDARD SPECIFICATIONS FOR SHOVEL-RUN OR CRUSHER-RUN BROKEN SLAG FOR WATERBOUND BASE

(A.S.T.M. DESIGNATION: D 66 – 23)[1]

Section 4.—Omit this section, reading as follows, renumbering the subsequent sections accordingly:

> 4. The percentage of wear shall be not more than 15.0 per cent.

Section 6 (b).—Omit this paragraph which refers to the method for determining the percentage of wear.

STANDARD SPECIFICATIONS FOR BLOCK FOR GRANITE BLOCK PAVEMENTS

(A.S.T.M. DESIGNATION: D 59 – 26)[1]

Section 3 (a).—Change to read as follows by the addition of the italicized words:

> 3. (*a*) The percentage of wear and the French coefficient of wear shall be determined in accordance with the Standard Method of Test for Abrasion of Rock (A.S.T.M. Designation: D 2) of the American Society for Testing Materials, *except that the sample shall be prepared by use of a press and the fragments shall be as uniform and as nearly cubical as practicable.*

STANDARD SPECIFICATIONS FOR BLOCK FOR RECUT GRANITE BLOCK PAVEMENTS

(A.S.T.M. DESIGNATION: D 131 – 23)[1]

Section 3 (a).—Make the same change as in Section 3 (*a*) of Specifications D 59 – 26 above.

STANDARD SPECIFICATIONS FOR BLOCK FOR DURAX GRANITE PAVEMENTS

(A.S.T.M. DESIGNATION: D 132 – 23)[1]

Section 3 (a).—Make the same change as in Section 3 (*a*) of Specifications D 59 – 26 above.

STANDARD SPECIFICATIONS FOR STRUCTURAL WOOD JOIST, PLANKS, BEAMS, STRINGERS AND POSTS

(A.S.T.M. DESIGNATION: D 245 – 27)[2]

In cooperation with the Committee on Wooden Bridges and Trestles of the American Railway Engineering Association, the

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[1] 1927 Book of A.S.T.M. Standards, Part II, pp. 453, 445, 447, 449, respectively. Criticisms of this revision are solicited and should be directed to Mr. Prévost Hubbard, Secretary of Committee D-4 on Road and Paving Materials, 441 Lexington Ave., New York City.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 581. Criticisms of this revision are solicited and should be directed to Mr. J. A. Newlin, Secretary of Committee D-7 on Timber, U. S. Forest Products Laboratory, Madison, Wis.

Standard Specifications for Structural Wood Joist, Planks, Beams, Stringers and Posts (D 245 – 27) have been reviewed and a number of changes agreed upon. The changes embody none of substance, with the exception of the omission of Southern Pine from the select grading and the introduction of dense common for Douglas Fir and Southern Pine. Southern Pine remains in the dense select grade, but it was claimed that any Southern Pine of close grain would also be dense and that it worked a hardship to supply material in a close grained material because it would automatically be dense and hence should be of the dense select grade. Beyond this, all changes were amplifications for the purpose of making the specifications more complete and clearer. The strength of clear wood has been added as a factor of strength and green wood is used as the basis of working stresses.

The rules for structural grades have been changed to conform to the "Basic Provisions for the Selection and Inspection of Softwood Dimension and Timbers Where Working Stresses are Required," recommended by the Structural Timber Conference held in Chicago, Ill., November 20, 1928, as approved by the Central Committee on Lumber Standards, Chicago, Ill., December 7, 1928. A new section was added on the calculation and determination of working stresses but no changes were made in the working stresses themselves. A number of charts have been added showing the relation between defects and strength. Formulas for the effect of knots have been included together with an explanation of their development. Sections on the effect of shakes and checks and effect of slope of grain have been added as a basis for and to supplement the charts.

STANDARD SPECIFICATIONS FOR RUBBER PUMP VALVES

(A.S.T.M. DESIGNATION: D 151 – 23)[1]

Section 4 (c).—Eliminate reference to reclaimed rubber.

STANDARD METHODS OF TESTING SHELLAC

(A.S.T.M. DESIGNATION: D 29 – 25)[2]

A revision in the form of separate tentative methods entitled "Methods of Sampling and Testing Shellac (D 29 – 29 T)"[3] is intended to replace, when adopted, the present Standard Methods of Testing

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 841. Criticisms of this revision are solicited and should be directed to Mr. Arthur W. Carpenter, Secretary of Committee D-11 on Rubber Products, The B. F. Goodrich Co., Akron, Ohio.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 292. Criticisms of this revision are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

[3] See p. 655.

Shellac (D 29 – 25)[1] and also the Standard Method of Test for Determination of Wax in Shellac ("Machine-Made" and Dry-Bleached Refined Shellac) (D 29 – 28).[2]

STANDARD METHOD OF TEST FOR VISCOSITY OF PETROLEUM PRODUCTS AND LUBRICANTS

(A.S.T.M. DESIGNATION: D 88 - 26)[3]

Section 1 (*c*).—Add a new sentence to this paragraph, to read as follows:

The Staybolt Furol Viscosimeter shall not be used for times of flow less than 25 seconds.

Section 3.—Change Paragraph (*b*) to read as follows by the addition of the italicized figures:

(*b*) With the Staybolt Furol Viscosimeter, determinations shall be made at *77,* 122 ***or*** *212°* F. (*25,* 50 ***or*** *100°* C.).

Omit Paragraph (*d*) of this section, reading as follows:

(*d*) Fuel oils and other oils of similar viscosity showing a time of less than 25 seconds, Saybolt Furol, at 122° F., shall be tested on the Saybolt Universal at 122° F. Oil showing a time of less than 32 seconds, Saybolt Universal, at 122° F., shall be measured in the Saybolt Universal at 100° F. (37.8° C.). These methods of test do not apply to fuels having a viscosity at 100° F. of less than 32 seconds Saybolt Universal, which are not considered to be fuel oils.

Section 4.—Change the first paragraph to read as follows, by the addition of the italicized words and figures and the omission of the word in brackets:

4. [In] ***For*** tests at *77,* 100, *122* and 130° F. (*25,* 37.8, *50* and 54.4° C.) the bath temperature throughout the test shall not vary more than ±0.1° F. (0.06° C.) from the predetermined temperature which will maintain thermal equilibrium as long as the oil is well stirred with the thermometer. In tests at 210 ***and 212° F.*** (98.9 ***and 100° C.***) a variation of ±0.2° F. (0.11° C.) is permitted

Change the first sentence of the second paragraph to read as follows, by the addition of the italicized words and figures and the omission of the words in brackets:

Any construction of bath may be employed provided the bath temperature necessary to maintain thermal equilibrium (while the oil in the oil tube is well stirred by the oil tube thermometer) ***is within ±0.1° F. (0.06° C.) from the standard temperature of 77° F. (25° C.) or*** is not in excess of 100.25, 122.35, 130.50 [and] 212.00 ***or 214.00° F.*** (37.9, 50.2, 54.7 [and] 100.00 ***and 101.1° C.***) respectively, for the ***other*** standard temperatures previously mentioned.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 292.

[2] 1928 Supplement to Book of A.S.T.M. Standards, p. 117.

[3] 1927 Book of A.S.T.M. Standards, Part II, p. 427. Criticisms of this revision are solicited and should be directed to Mr. R. P. Anderson, Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

STANDARD METHOD OF TEST FOR DISTILLATION OF GASOLINE, NAPHTHA, KEROSINE, AND SIMILAR PETROLEUM PRODUCTS

(A.S.T.M. DESIGNATION: D 86 – 27)[1]

Section 8 (*d*).—Change the footnote to this section from its present form: namely,

> For products having an initial boiling point of 212° F. (100° C.) or higher, the High-Distillation Thermometer shall be used; for all other products, the Low-Distillation Thermometer shall be used,

to read as follows:

> For products having end points not higher than 482° F. (250° C.) or initial boiling points not higher than 212° F. (100° C.), the Low-Distillation Thermometer shall be used; for all other products, the High-Distillation Thermometer shall be used.

STANDARD METHOD OF TEST FOR WATER IN PETROLEUM PRODUCTS AND OTHER BITUMINOUS MATERIALS

(A.S.T.M. DESIGNATION: D 95 – 28)[2]

Section 5.—Change the last sentence to read as follows, by the addition of the italicized words and figures and the omission of the figure in brackets:

> The end of the condenser to be inserted in the trap shall be ground off at an angle of [60] *30* deg. *from the vertical axis of the condenser.*

Section 9.—Add the following sentence after the first sentence of the second paragraph:

> The end of the condenser inserted in the trap shall be adjusted to that position which will allow the end to be submerged to a depth of not more than 1 mm. below the surface of the liquid in the trap after distillation conditions have been established.

STANDARD METHOD OF TEST FOR CARBON RESIDUE OF PETROLEUM PRODUCTS (CONRADSON CARBON RESIDUE)

(A.S.T.M. DESIGNATION: D 189 – 28)[2]

Section 2 (*c*).—Change the first sentence to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

> Spun sheet-iron crucible, with cover; about 200-ml. (7-oz.) capacity, 80 mm. (3⅛ in.) in outside diameter at the top, 58 to 60 mm. (about 2⅜ in.) in height, approximately 0.8 mm. (1/32 in.) in thickness and weighing, without cover, [70 to 75 g. (about 2½ oz.)] *65 to 85 g.* (*about 2¼ to 3 oz.*).

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 378. Criticisms of this revision are solicited and should be directed to Mr. R. P. Anderson, Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

[2] 1928 Supplement to Book of A.S.T.M. Standards, pp. 148, 129. Criticisms of this revision are solicited and should be directed to Mr. R. P. Anderson, Secretary of Committee D-2 on Petroleum Products and Lubricants, 250 Park Ave., New York City.

STANDARD METHODS OF LABORATORY SAMPLING AND ANALYSIS OF COAL AND COKE

(A.S.T.M. DESIGNATION: D 271 – 29)[1]

Section 15.—Under Method *B*, using Meker Burner for determination of volatile matter, the temperature may be indicated by the fusion of pure K_2CrO_4 in the covered crucible. It is stated in the fourth sentence that the fusion point of pure K_2CrO_4 is 940° C. This temperature was taken from determinations made by Le Chatelier and published in 1894. Later determinations show that the temperature given is too low. Recent determinations made by Smith and Hartgen[1] of the U. S. Bureau of Mines show that the melting point of pure K_2CrO_4 is 968° C. It is recommended that the temperature for fusion of K_2CrO_4 be changed from "940° C." to read "968° C.," with the following footnote:

U. S. Bureau of Mines *Reports of Investigations*, Serial No. 2917 (1929).

Section 20.—The present temperature (870–925° C.) given for ignition of coal and coke with Eschka mixture in the determination of sulfur is unnecessarily high and if porcelain crucibles are used they are short lived due to the action of the Eschka mixture on the crucibles at this temperature. Experiments have been made with different coals and cokes to show that lower temperatures give accurate results. Committee D-5 accordingly recommends revisions in Paragraphs (*c*) and (*d*) of this section, as follows:

Change Paragraph (*c*) to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

(*c*) (For Coal).—Place the crucible in a cold muffle and gradually raise the temperature to [870–925° C. (cherry-red heat)] *800° C. ±25° C.* in about 1 hour. Maintain [the] *this* maximum temperature for about 1½ hours [and then allow the crucible to cool in the muffle].

Change Paragraph (*d*) to read as follows by the addition of the italicized words and figures and the omission of those in brackets:

(*d*) (For Coke).—Place the crucible in a warm muffle and gradually raise the temperature to [870–925° C. (cherry-red heat)] *800° C. ±25° C.* in about 30 minutes. Maintain this maximum temperature until on stirring all black particles have disappeared.

Section 40 (*a*).—Change the last sentence to read as follows by the addition of the italicized words:

The bomb shall have an inner surface *and accessory fittings, including crucible,* of platinum, gold, porcelain enamel, or other material which is not attacked by HNO_3 and H_2SO_4, or other products of combustion.

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[1] 1929 Supplement to Book of A.S.T.M. Standards, p. 212. Criticisms of this revision are solicited and should be directed to Mr. W. A. Selvig, Secretary of Committee D-5 on Coal and Coke, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.

STANDARD METHODS OF SAMPLING AND ANALYSIS OF CREOSOTE OIL

(A.S.T.M. DESIGNATION: D 38 – 27)[1]

Section 4.—Change the last sentence of the first paragraph to read as follows by the addition of the italicized figure and the omission of the words and figure in brackets:

> If more than [2] *3* per cent of water is present, [or if the water is apparently present to an extent in excess of 2 per cent, but an accurate separation is impossible,] the percentage of water present shall be determined by the following method, and the water-free oil so obtained shall be used in the distillation test:

Section 9.—Replace the second and third sentences: namely,

> In case the oil requires to be brought to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by adding 0.0008 to the observed specific gravity for each degree Centigrade above 38° C. at which the test is made. This correction factor does not apply with equal accuracy to all oils, but serious error due to its use will be avoided if the foregoing precaution is observed, with respect to avoiding unnecessarily high temperature.

by a single sentence reading as follows:

> In case it is necessary to bring the oil to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by selecting the appropriate factor from Tables I and II shown in the Appendix.

Add as an Appendix to these methods the accompanying Tables I and II giving factors for use in correcting the volume of creosote oil from observed temperatures to 100° F. Precede the tables with the following introductory paragraph:

> The accompanying Tables I and II were prepared by the U. S. Bureau of Standards to meet the demand of the users and producers of creosote oil for accurate correction factors. The tables have been adopted as standard by the American Wood Preservers' Association and are being considered for adoption by the American Railway Engineering Association; they are the outcome of a Joint Conference Committee representing these associations and the American Society for Testing Materials. Special attention is directed to the importance of the note of warning with regard to measurement of oil at temperatures below 100° F.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 683. Criticisms of this revision are solicited and should be directed to Mr. J. A. Newlin, Secretary of Committee D-7 on Timber, U. S. Forest Products Laboratory, Madison, Wis.

TABLE I.—FACTORS TO BE USED FOR CORRECTING THE SPECIFIC GRAVITY OF CREOSOTE OIL TO 100° F. WHEN THE OIL IS AT TEMPERATURES RANGING FROM 60 TO 220° F.

GROUP I.—For Distillate Creosote Including Distillate Water-Gas-Tar Creosote, Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Below 1.0900.

GROUP II.—For High-Boiling Distillate Creosote or Anthracene Oils Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Above 1.0900.

Observed Temperature, deg. Fahr.	Correction Factor to be Added to Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Added to Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Added to Observed Specific Gravity	
	Group I	Group II		Group I	Group II		Group I	Group II
220	0.0491	0.0468	180	0.0326	0.0312	140	0.0161	0.0156
219	0.0487	0.0464	179	0.0322	0.0308	139	0.0157	0.0152
218	0.0483	0.0460	178	0.0318	0.0304	138	0.0153	0.0148
217	0.0479	0.0457	177	0.0314	0.0301	137	0.0149	0.0144
216	0.0475	0.0453	176	0.0309	0.0297	136	0.0145	0.0140
215	0.0471	0.0449	175	0.0305	0.0293	135	0.0141	0.0136
214	0.0467	0.0445	174	0.0301	0.0289	134	0.0137	0.0132
213	0.0462	0.0441	173	0.0297	0.0285	133	0.0133	0.0128
212	0.0458	0.0437	172	0.0293	0.0281	132	0.0129	0.0124
211	0.0454	0.0433	171	0.0289	0.0277	131	0.0125	0.0120
210	0.0450	0.0429	170	0.0284	0.0273	130	0.0121	0.0117
209	0.0446	0.0425	169	0.0280	0.0269	129	0.0117	0.0113
208	0.0442	0.0421	168	0.0276	0.0265	128	0.0113	0.0109
207	0.0438	0.0418	167	0.0272	0.0261	127	0.0109	0.0105
206	0.0434	0.0414	166	0.0268	0.0257	126	0.0105	0.0101
205	0.0430	0.0410	165	0.0264	0.0253	125	0.0101	0.0097
204	0.0426	0.0406	164	0.0260	0.0250	124	0.0097	0.0093
203	0.0422	0.0402	163	0.0256	0.0246	123	0.0093	0.0089
202	0.0418	0.0398	162	0.0252	0.0242	122	0.0089	0.0085
201	0.0413	0.0394	161	0.0248	0.0238	121	0.0084	0.0081
200	0.0409	0.0390	160	0.0244	0.0234	120	0.0080	0.0078
199	0.0405	0.0386	159	0.0239	0.0230	119	0.0076	0.0074
198	0.0401	0.0382	158	0.0234	0.0226	118	0.0072	0.0070
197	0.0397	0.0378	157	0.0230	0.0222	117	0.0068	0.0066
196	0.0392	0.0374	156	0.0226	0.0218	116	0.0064	0.0062
195	0.0388	0.0371	155	0.0222	0.0214	115	0.0060	0.0058
194	0.0384	0.0367	154	0.0218	0.0210	114	0.0056	0.0054
193	0.0380	0.0363	153	0.0214	0.0206	113	0.0052	0.0050
192	0.0375	0.0359	152	0.0210	0.0202	112	0.0048	0.0046
191	0.0371	0.0355	151	0.0206	0.0199	111	0.0044	0.0043
190	0.0367	0.0351	150	0.0202	0.0195	110	0.0040	0.0039
189	0.0363	0.0347	149	0.0198	0.0191	109	0.0036	0.0035
188	0.0359	0.0343	148	0.0194	0.0187	108	0.0032	0.0031
187	0.0355	0.0340	147	0.0190	0.0183	107	0.0028	0.0027
186	0.0351	0.0336	146	0.0186	0.0179	106	0.0024	0.0023
185	0.0347	0.0332	145	0.0182	0.0175	105	0.0020	0.0019
184	0.0343	0.0328	144	0.0177	0.0171	104	0.0016	0.0016
183	0.0339	0.0324	143	0.0173	0.0167	103	0.0012	0.0012
182	0.0334	0.0320	142	0.0169	0.0163	102	0.0008	0.0008
181	0.0330	0.0316	141	0.0165	0.0160	101	0.0004	0.0004
						100	0.0000	0.0000

The portion of the table below should not be used unless the sample of oil has been examined and found free from crystals.

Observed Temperature, deg. Fahr.	Correction Factor to be Subtracted from Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Subtracted from Observed Specific Gravity		Observed Temperature, deg. Fahr.	Correction Factor to be Subtracted from Observed Specific Gravity	
	Group I	Group II		Group I	Group II		Group I	Group II
99	0.0004	0.0004	84	0.0063	0.0062	69	0.0122	0.0121
98	0.0008	0.0008	83	0.0067	0.0066	68	0.0126	0.0125
97	0.0012	0.0012	82	0.0071	0.0070	67	0.0130	0.0129
96	0.0016	0.0016	81	0.0075	0.0074	66	0.0134	0.0133
95	0.0020	0.0020	80	0.0079	0.0078	65	0.0138	0.0136
94	0.0024	0.0023	79	0.0083	0.0082	64	0.0142	0.0140
93	0.0028	0.0027	78	0.0087	0.0086	63	0.0146	0.0144
92	0.0032	0.0031	77	0.0091	0.0090	62	0.0150	0.0148
91	0.0036	0.0035	76	0.0095	0.0094	61	0.0154	0.0152
90	0.0040	0.0039	75	0.0099	0.0098	60	0.0158	0.0156
89	0.0043	0.0043	74	0.0103	0.0101			
88	0.0047	0.0047	73	0.0107	0.0105			
87	0.0051	0.0051	72	0.0111	0.0109			
86	0.0055	0.0055	71	0.0115	0.0113			
85	0.0059	0.0058	70	0.0118	0.0117			

TABLE II.—FACTORS TO BE USED FOR DETERMINING THE VOLUME OF CREOSOTE OIL AT 100° F. WHEN THE OIL IS AT TEMPERATURES RANGING FROM 60 TO 220° F.

Group I.—For Distillate Creosote Including Distillate Water-Gas-Tar Creosote, Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Below 1.0900.

Group II.—For High Boiling Distillate Creosote Oils Having a Specific Gravity at 100°/60° F. (37.8°/15.56° C.) Above 1.0900.

The observed volume is to be multiplied by the factor corresponding to the observed temperature.

Observed Temperature, deg. Fahr.	Volume at 100° F. Occupied by Unit Volume at Indicated Temperature		Observed Temperature, deg. Fahr.	Volume at 100° F. Occupied by Unit Volume at Indicated Temperature		Observed Temperature, deg. Fahr.	Volume at 100° F. Occupied by Unit Volume at Indicated Temperature	
	Group I	Group II		Group I	Group II		Group I	Group II
220	0.9526	0.9570	180	0.9684	0.9711	140	0.9842	0.9855
219	0.9530	0.9573	179	0.9687	0.9714	139	0.9846	0.9858
218	0.9534	0.9577	178	0.9691	0.9718	138	0.9850	0.9862
217	0.9538	0.9580	177	0.9695	0.9721	137	0.9853	0.9866
216	0.9542	0.9584	176	0.9699	0.9725	136	0.9857	0.9869
215	0.9546	0.9587	175	0.9703	0.9729	135	0.9861	0.9873
214	0.9550	0.9591	174	0.9707	0.9732	134	0.9865	0.9876
213	0.9554	0.9594	173	0.9711	0.9736	133	0.9869	0.9880
212	0.9558	0.9598	172	0.9715	0.9739	132	0.9873	0.9884
211	0.9561	0.9601	171	0.9719	0.9743	131	0.9877	0.9887
210	0.9565	0.9605	170	0.9723	0.9746	130	0.9881	0.9891
209	0.9569	0.9608	169	0.9727	0.9750	129	0.9885	0.9894
208	0.9573	0.9612	168	0.9731	0.9754	128	0.9889	0.9898
207	0.9577	0.9615	167	0.9735	0.9757	127	0.9893	0.9902
206	0.9581	0.9619	166	0.9739	0.9761	126	0.9897	0.9905
205	0.9585	0.9622	165	0.9743	0.9764	125	0.9901	0.9909
204	0.9589	0.9626	164	0.9747	0.9768	124	0.9905	0.9913
203	0.9593	0.9629	163	0.9751	0.9772	123	0.9909	0.9916
202	0.9597	0.9633	162	0.9754	0.9775	122	0.9913	0.9920
201	0.9601	0.9636	161	0.9758	0.9779	121	0.9917	0.9923
200	0.9605	0.9640	160	0.9762	0.9782	120	0.9921	0.9927
199	0.9609	0.9644	159	0.9766	0.9786	119	0.9925	0.9931
198	0.9612	0.9647	158	0.9770	0.9790	118	0.9929	0.9934
197	0.9616	0.9650	157	0.9774	0.9793	117	0.9932	0.9938
196	0.9620	0.9654	156	0.9778	0.9797	116	0.9936	0.9942
195	0.9624	0.9658	155	0.9782	0.9800	115	0.9940	0.9945
194	0.9628	0.9661	154	0.9786	0.9804	114	0.9944	0.9949
193	0.9632	0.9665	153	0.9790	0.9808	113	0.9948	0.9952
192	0.9636	0.9668	152	0.9794	0.9811	112	0.9952	0.9956
191	0.9640	0.9672	151	0.9798	0.9815	111	0.9956	0.9960
190	0.9644	0.9675	150	0.9802	0.9819	110	0.9960	0.9963
189	0.9648	0.9679	149	0.9806	0.9822	109	0.9964	0.9967
188	0.9652	0.9682	148	0.9810	0.9826	108	0.9968	0.9971
187	0.9656	0.9686	147	0.9814	0.9830	107	0.9972	0.9974
186	0.9660	0.9689	146	0.9818	0.9833	106	0.9976	0.9978
185	0.9664	0.9693	145	0.9822	0.9837	105	0.9980	0.9982
184	0.9668	0.9696	144	0.9826	0.9840	104	0.9984	0.9985
183	0.9672	0.9700	143	0.9830	0.9844	103	0.9988	0.9989
182	0.9676	0.9704	142	0.9834	0.9848	102	0.9992	0.9992
181	0.9680	0.9707	141	0.9838	0.9851	101	0.9996	0.9996
						100	1.0000	1.0000

The portion of the table below should not be used unless the sample of oil has been examined and found free from crystals.

99	1.0004	1.0004	84	1.0063	1.0057	69	1.0122	1.0111
98	1.0008	1.0007	83	1.0067	1.0061	68	1.0126	1.0115
97	1.0012	1.0011	82	1.0071	1.0065	67	1.0130	1.0118
96	1.0016	1.0014	81	1.0075	1.0068	66	1.0134	1.0122
95	1.0020	1.0018	80	1.0079	1.0072	65	1.0138	1.0126
94	1.0024	1.0022	79	1.0083	1.0075	64	1.0142	1.0129
93	1.0028	1.0025	78	1.0087	1.0079	63	1.0146	1.0133
92	1.0032	1.0029	77	1.0091	1.0083	62	1.0150	1.0136
91	1.0036	1.0032	76	1.0095	1.0086	61	1.0154	1.0140
90	1.0040	1.0036	75	1.0099	1.0090	60	1.0158	1.0144
89	1.0043	1.0040	74	1.0103	1.0093			
88	1.0047	1.0043	73	1.0107	1.0097			
87	1.0051	1.0047	72	1.0111	1.0100			
86	1.0055	1.0050	71	1.0115	1.0104			
85	1.0059	1.0054	70	1.0118	1.0108			

STANDARD METHOD OF TEST FOR DISTILLATION OF CREOSOTE OIL

(A.S.T.M. DESIGNATION: D 246 - 28)[1]

Section 8.—Change the phrase "If the presence of water is suspected or known" to read "If the presence of 3 per cent of water is suspected or known."

Section 10.—Add a new paragraph to read as follows:

(*f*) If the fraction 0 to 210° C. contains water the amount of water shall be determined. This amount shall then be deducted from the weight of oil taken and all of the fractions shall be corrected to a percentage based on dry oil. A convenient method for determining the amount of water is to transfer this fraction, after weighing, to a tube or cylinder graduated in 0.1 cc. and add benzol. This almost always causes a clear separation between the oil and water.

STANDARD METHODS OF TESTING ELECTRICAL INSULATING OILS

(A.S.T.M. DESIGNATION: D 117 - 27)[2]

1. *Scope.*—These methods are intended for oil used in transformers, oil circuit breakers and similar electrical apparatus as an insulating or cooling medium, or both.

SAMPLING

2. *General.*—Samples shall be taken and handled in such a manner that the tests made upon them indicate the characteristics of the shipment. Some tests are greatly affected by the most minute traces of impurities. This is particularly the case with the sludge test[3] and the dielectric strength test, the latter being affected by almost infinitesimal traces of moisture. If these tests are to be made, it is important that the samples be handled with the utmost care to prevent such contamination. All tests are usually made on samples taken from drums. In some cases dielectric strength tests are not made on samples taken from tank cars. Samples from tank cars are usually tested only for the physical and chemical properties which are not affected by *slight* amounts of moisture; care, however, shall be exercised not to introduce into such samples extraneous contamination which might affect the sludge test.[3] It is imperative, therefore, that the procedure and precautions for obtaining and transporting samples of the oil to be tested, as specified in Sections 3 to 8, inclusive, shall be observed.

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[1] 1928 Supplement to Book of A.S.T.M. Standards, p. 163. Criticisms of this revision are solicited and should be directed to Mr. J. A. Newlin, Secretary of Committee D-7 on Timber, U. S. Forest Products Laboratory, Madison, Wis.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 796. Criticisms of these revisions are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corporation, 230 Grove St., Bloomfield, N. J.

This proposed revision, when accepted, will supersede Sections 1 to 7 of the present Standard Methods of Testing Electrical Insulating Oils (A.S.T.M. Designation: D 117 - 27).

[3] The great importance of a sludging test is recognized but none is included in this Standard at this time because none of the methods in general use are considered sufficiently satisfactory by Committee D-9 to warrant consideration for standardization purposes. Certain new methods are being actively investigated. See reports of Committee D-9 for 1922, 1923, 1924, 1925, 1926, 1927, 1928 and 1929. For such reports see Part I of the *Proceedings* of the American Society for Testing Materials, Vols. 22 to 29, respectively.

APPARATUS

3. *Thiefs.* (*a*) *General.*—Thiefs shall be used for withdrawing samples of oil from drums, tank cars, or other containers in which shipment is made. Glass or metal thiefs may be used.

(*b*) *For Drums.*—For sampling drums or smaller containers the thiefs shall be of suitable design so as to reach within approximately $\frac{1}{8}$ in. (about 3 mm.) of the bottom and should have a capacity of approximately 1 pt. or 1 qt. (0.5 or 1 liter). For sampling the smaller containers a proportionately smaller similar thief may be used.

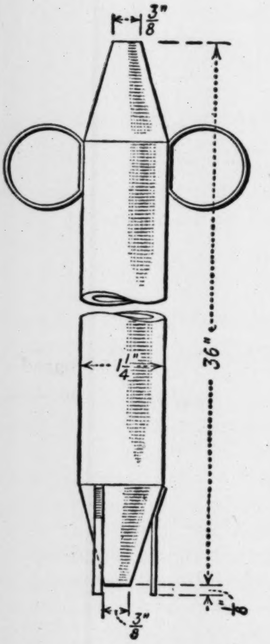

FIG. 1.—Thief for Sampling Drums.

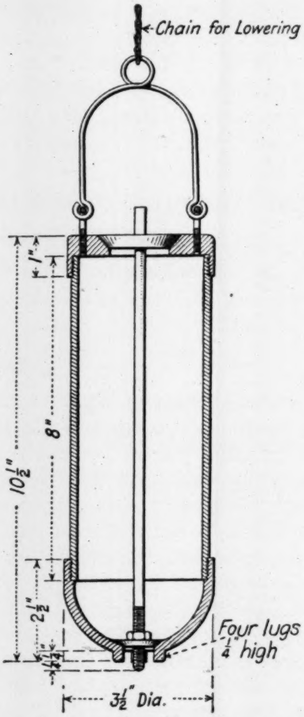

FIG. 2.—Thief for Sampling Tank Cars.

NOTE.—A convenient and simple thief for sampling 50-gal. drum containers is shown in Fig. 1, which illustrates a sheet metal thief 36 in. in length, $1\frac{1}{4}$ in. in diameter, with cone-shaped caps over the ends and having openings at the ends $\frac{3}{8}$ in. diameter. Three legs, equally spaced around the thief at the lower end, long enough to hold the opening $\frac{1}{8}$ in. from the bottom of the container, aid in securing a good representative sample. Two rings soldered to opposite sides of the tube at the upper end will be found convenient for holding the thief by slipping two fingers through them, leaving the thumb free to close the opening.

(*c*) *For Tank Cars.*—For sampling tank cars the thief shall be designed so as to make it possible to secure the sample from within at least 0.5 in. of the bottom.

NOTE.—A thief suitable for sampling tank cars may be made from metal tubing and castings, machine-finished all over. A valve rod, whose projecting stem strikes the bottom of the car, opens the valve automatically and simultaneously releases the air through the top. Such a thief is illustrated in Fig. 2.

4. *Sample Containers.*—Tin cans or cork or glass-stoppered clear-glass bottles in cartons may be used as containers for the samples. The containers shall be clean and dry.

NOTE.—The clear-glass bottle offers the advantage that it may be examined to see that it is clean. It also allows visual inspection of the oil before testing, permitting the detection of free water or solid impurities. However, if samples are placed in glass bottles, they shall be kept in the dark until portions are removed for testing for color and sludge forming characteristics, as light produces changes in these properties. For this reason cardboard cartons with covers shall be provided for each bottle into which the bottle with its sample of oil shall be placed immediately after sampling. Rubber stoppers shall never be used. When cork is used it shall be of good quality with a new cork for each sample. Contact of the oil with the cork may be prevented by wrapping some tin or aluminum foil around the cork before forcing it into the mouth of the bottle. If glass-stoppered bottles are used, precaution shall be taken to insure that perfectly fitting stoppers are secured. A tin can fitted with a screw cap protected with a cork disk faced with tin or aluminum will endure harder usage. If tin cans are to be employed, only those having seams soldered on the exterior surfaces shall be used.

5. *Cleaning of Apparatus.* (*a*) *General.*—All thiefs and sample containers shall be cleaned thoroughly before using, special care being taken that no lint or other fibrous material remains in or on them. Care shall be taken to insure the complete removal of all traces of soldering flux from new thiefs and new cans.

NOTE 1.—Thiefs and containers which are not chemically clean and dry are likely to contaminate the samples and cause misleading results on some of the tests.

NOTE 2.—To insure the greatest ease in removing traces of soldering flux, a flux of rosin in a suitable solvent is recommended for soldering all seams. Such a flux is easily removed with gasoline, whereas, many other fluxes are very hard to remove. Minute traces of flux may contaminate the sample so that the results obtained on dielectric strength tests and various sludge tests may be erroneous.

(*b*) *Thiefs.*—Thiefs, before using, shall be cleaned by rinsing with oil-free gasoline and dried in the hot cabinet described in Section 6 (*a*). The best procedure is to rinse them after the sampling has been finished and then place them in the hot cabinet, as in this way they will be ready for use without further cleaning when the next shipment is to be sampled.

(*c*) *Sample Containers.*—Sample containers, before using, shall be rinsed with oil-free gasoline and dried. They shall then be washed with strong soapsuds, rinsed thoroughly with distilled water and then dried by passing a current of warm air through the containers, after which they shall be immediately placed in the hot cabinet described in Section 6 (*a*). A similar washing will be sufficient for re-use of the containers which have held new oil, but those which have contained used oil shall be washed with both gasoline and benzol before using soapsuds.

6. *Storage of Apparatus.* (*a*) *General* —When not in use all thiefs and sample containers shall be kept in a hot, dry, dust-free cabinet or compartment at a temperature not less than 38° C. (100° F.).

(*b*) *Thiefs.*—Thiefs shall be kept at all times in a vertical position in the hot cabinet in a rack having a suitable drainage receptacle at the base.

(*c*) *Sample Containers.*—Containers for samples, after washing and drying as described in Section 5 (*c*), shall be kept unstoppered while in the hot cabinet but shall be closed immediately on removal. In cases where it is necessary to prepare, in advance, containers which cannot be kept in the hot cabinet until approximately such time as the sample is placed therein (as for example, when bottle containers are prepared to be sent to a distant sampling point) the same procedure of washing and drying shall be followed as described in Section 5 (*c*). In these cases, after the bottles are corked or stoppered and removed from the hot cabinet, the corks or stoppers shall be capped with paper which is tied securely on the neck, and then the capped corks or stoppers shall be sealed by dipping into melted paraffin wax so as to cover all of the paper cap and part of the neck. If this procedure is followed, care shall be taken in removing the paraffined caps preparatory to filling the bottles with samples, that no paraffin contaminates the sample.

PROCEDURE

7. *Procedure for Sampling New Oils.* (*a*) *General.*—A sufficient number of samples shall be taken to cover the requirements of the tests. It is recommended that 1 qt. of oil be taken as a sample if complete physical and chemical tests are to be made and at least 1 pt. if only the dielectric strength tests are to be made.

(*b*) Drums, tank cars, or other containers of oil shall not be sampled until the oil is at least as warm as the surrounding air, because cold oil may condense enough moisture from a humid atmosphere to affect seriously its insulating properties. Samples shall, of course, never be taken in the rain and precautions shall be taken during sampling to prevent contamination such as that which may occur from wind-blown dust or other sources.

(*c*) Samples of oil from drums and cans shall be taken only after the oil has remained undisturbed for at least eight hours.

(*d*) Drums and barrels of oil to be sampled shall be lined up, preferably on their sides with their bungs up. The bungs shall be unsealed, removed, and laid with the oily sides up beside the bung holes. The top hole of the thief shall be closed with the thumb and the thief thrust about 1 ft. (30 cm.) into the oil. The thumb shall then be removed, allowing the oil to flow into the thief. The upper end of the thief shall again be closed with the thumb and the thief withdrawn. The oil remaining in the thief shall be used for rinsing out the thief by holding the thief nearly horizontal and turning so that the oil comes in contact with that part of the inside surface of the thief which is immersed when taking the final sample. During this rinsing of the thief, care shall be taken to avoid handling any portion of the thief which is subsequently immersed in the oil to be sampled as moisture from the fingers or hands may be sufficient to cause enough contamination of the oil to secure a low value in dielectric strength test. The oil used for rinsing shall be thrown away and the thief allowed to drain. The thief shall again be inserted into the oil but this time the thumb is not removed until the thief reaches the bottom of the container.

When the thief is filled, the thumb shall be replaced, the thief quickly withdrawn and the contents allowed to flow into the sample container. The bottom hole shall not be closed with the fingers of the other hand. The free hand shall be used to guide the stream of oil by touching the thief only as necessary. The oil shall not be allowed to flow over the hand or fingers before it flows into the sample container nor shall any excess be allowed to flow over the drum or barrel and back again through the open bung hole. When the sample container is filled it shall be closed quickly and the bung replaced in the drum and tightened. The sample container shall be labeled at once and taken to the testing laboratory as quickly as feasible.

(*e*) Smaller containers, such as cans, shall be sampled with the drum thief or a proportionately smaller similar thief using a method similar in general to the one described for drums and barrels in Paragraph (*d*).

(*f*) Tank cars of oil shall be sampled by introducing the tank-car thief through the manhole on top of the car, the cover of which shall be removed carefully so as not to introduce any dirt into the oil. The thief shall be lowered until it strikes the bottom of the tank car when it automatically opens and fills. Under no conditions shall samples be taken from the bottom draw-off.

(*g*) When separate samples are being taken from a consignment or part of a consignment, care shall be exercised to prevent contaminating the samples. A separate thief shall be used for each sample or the thief previously used shall be well drained and then thoroughly washed with oil from the next container to be sampled, throwing away the oil thus used for washing, before taking the portion reserved for the sample (see Section 7(*d*)). Enough thiefs shall be provided to insure thorough drainage of each thief after rinsing with oil to be sampled before using it to withdraw the sample. For obtaining only a few samples, two thiefs are sufficient, but for obtaining a large number of samples (for example, sampling a carload of drummed oil) six or more are desirable.

(*h*) When one average sample of a consignment or batch is being taken, the same thief may be used throughout the sampling operation, omitting the precaution of rinsing the thief with oil before taking any of the portions that go to make up the total average sample.

8. *Procedure for Sampling Oil in Service.*—When taking samples of oil from transformers, oil circuit breakers and similar electrical apparatus where a thief cannot be used, the precautions outlined in the preceding sections shall be observed so far as practicable. In addition, care shall be taken to procure a sample which fairly represents the oil at the bottom of the tank. Transformer and oil circuit-breaker tanks, and similar electrical apparatus are usually provided with drain pipes or sampling cocks from which the sample may be allowed to flow into the sample container. Sufficient oil shall first be allowed to flow to waste through these drain pipes or sampling cocks before the sample is taken, in order to insure that the sample will not be that portion which was stored in the drain pipe. For this reason, the valve and the drain pipe should be sufficiently small to be emptied with convenience and yet sufficiently large to give an even flow of oil and avoid clogging by sediment. A U. S. Standard ¼-in. nominal size pipe (equivalent to an inside diameter of approximately 9 mm.) with suitable valve are recommended. This, of course, may be separate from the drainage pipe and valve or may be connected to the drainage valve by means of a suitable reducer.

STANDARD METHODS OF TESTING MOLDED INSULATING MATERIALS

(A.S.T.M. DESIGNATION: D 48 – 29)[1]

Section 23.—Change from its present form: namely,

23. The test specimen No. 3 shown in Fig. 2 (the accompanying Fig. 3) shall be used for this test.

to read as follows:

23. The test specimen shall be molded in the form of a disk 4 in. (10.16 cm.) in diameter which should be ⅛ in. (3.18 mm.) in thickness for hot-molded materials, and ¼ in. (6.35 mm.) in thickness for cold-molded materials.

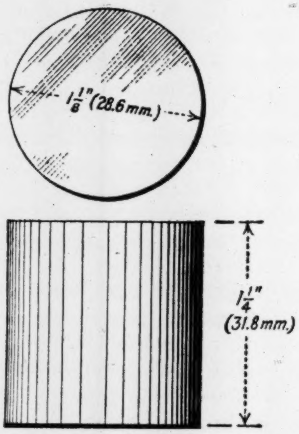

FIG. 3.—Compression Test Specimen. (Specimen No. 3.)

Figure 2.—The revision of Section 23 will necessitate the omission of Fig. 2 (the accompanying Fig. 3).

STANDARD METHODS OF TESTING RUBBER PRODUCTS

(A.S.T.M. DESIGNATION: D 15 – 24)[2]

A revision in the form of separate tentative methods of chemical analysis entitled "Methods of Chemical Analysis of Rubber Products (D 297 – 29 T)"[3] is intended to replace, when adopted, Sections 1 to 47 of the present standard methods.

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[1] 1929 Supplement to Book of A.S.T.M. Standards, p. 259. Criticisms of these revisions are solicited and should be directed to Mr. T. S. Taylor, Secretary of Committee D-9 on Electrical Insulating Materials, Bakelite Corporation, 230 Grove St., Bloomfield, N. J.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 847. Criticisms of this revision are solicited and should be directed to Mr. Arthur W. Carpenter, Secretary of Committee D-11 on Rubber Products, The B. F. Goodrich Co., Akron, Ohio.

[3] See p. 795.

STANDARD DEFINITIONS OF TERMS RELATING TO PAINT SPECIFICATIONS

(A.S.T.M. DESIGNATION: D 16 - 24)[1]

Add the following three new definitions of terms:

Screen (*Sieve*).—A plate or sheet or a woven cloth, or other device, with regularly spaced apertures of uniform size, mounted in a suitable frame or holder, for use in separating material according to size.

NOTE 1.—The shape and spacing of apertures, size of wires or threads, thickness of plate or sheet, allowable variations and similar properties should be taken care of in specifications.

NOTE 2.—In mechanical analysis testing work, when not otherwise specified, the term "sieve" shall apply to an apparatus in which the apertures are rectangular, and the term "screen" shall apply to an apparatus in which the apertures are circular.

Toughness.—That quality of a material which may be measured by the maximum impact which it will withstand without rupture.

Elasticity.—In the case of paint or varnish, that property which allows a film to follow, without rupture, changes in the extent and form of the surface to which it is applied.

STANDARD DEFINITIONS OF TERMS RELATING TO COAL AND COKE

(A.S.T.M. DESIGNATION: D 121 - 27)[2]

Several definitions of terms published under the title "Tentative Definitions of Terms Relating to Coal and Coke (D 121 - 27 T)"[3] are intended to be added to the present standard definitions.

STANDARD DEFINITIONS OF TERMS RELATING TO STRUCTURAL TIMBER

(A.S.T.M. DESIGNATION: D 9 - 15)[4]

A revision in the form of separate tentative definitions entitled "Definitions of Terms Relating to Timber (D 9 - 29 T)"[5] is intended to replace, when adopted, the present standard definitions.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 346. Criticisms of this revision are solicited and should be directed to Mr. R. L. Hallett, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 105 York St., Brooklyn, N. Y.

[2] 1927 Book of A.S.T.M. Standards, Part II, p. 579. Criticisms of this revision are solicited and should be directed to Mr. W. A. Selvig, Secretary of Committee D-5 on Coal and Coke, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.

[3] *Proceedings*, Am. Soc. Testing Mats., Vol. 27 Part I, p. 962 (1927); also 1929 Book of A.S.T.M. Tentative Standards, p. 512.

[4] 1927 Book of A.S.T.M. Standards, Part II, p. 697. Criticisms of this revision are solicited and should be directed to Mr. J. A. Newlin, Secretary of Committee D-7 on Timber, U. S. Forest Products Laboratory, Madison, Wis.

[5] See p. 713.

STANDARD DEFINITIONS OF TERMS RELATING TO TEXTILE MATERIALS

(A.S.T.M. DESIGNATION: D 123 – 27)[1]

Several definitions of terms published under the title "Tentative Definitions of Terms Relating to Textile Materials (D 123 – 28 T)"[2] are intended to be added, when adopted, to the present standard definitions.

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[1] 1927 Book of A.S.T.M. Standards, Part II, p. 905. Criticisms of this revision are solicited and should be directed to Mr. J. E. Skane, Secretary of Committee D-13 on Textile Materials, Manhattan Rubber Manufacturing Co., Passaic, N J.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part I, p. 1105 (1928); also 1929 Book of A.S.T.M. Tentative Standards, p. 770.

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